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RELATION BETWEEN THE DISPOSITION OF THE ER AND KIDNEY AND THE FORM OF THE AIR ADDER IN CERTAIN SILUROID FISHES OF INDIA

By

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CORRELATION BETWEEN THE DISPOSITION OF THE LIVER AND THE KIDNEY AND THE FORM OF THE AIR-BLADDER IN CERTAIN SILUROID FISHES OF INDIA.[1]

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(*Read January 5, 1937.*)

Several workers have observed and commented upon the peculiar disposition of the liver and the kidneys in certain Siluroid genera, such as *Plotosus* Cuv. & Val., *Heteropneustes* Müller (=*Saccobranchus* Cuv. & Val.), *Clarias* Linn. and *Heterobranchus* Geoffr., but, so far as I am aware, no satisfactory explanation for this peculiarity has yet been advanced. Dutta (1924), who reviewed the whole subject not very long ago, came to the conclusion that

> 'This unusual position of the liver and the kidney can be regarded with a very fair amount of probability to be due to the smallness of the body-cavity in which the comparatively larger liver and kidney do not find enough space and are thus thrust outside.'

Weber (1891) had previously suggested that the peculiar disposition of the liver and the kidneys in *Clarias* and *Heterobranchus* was due to the lateral expansion of the air-bladder, which carries sideways with it small lobes of the liver and the kidneys.

It is unfortunate that Bridge and Haddon's (1893) very illuminating remarks concerning the peculiarities in the disposition of the liver in certain Siluroid fishes and its correlation with the form of the air-bladder should have escaped the attention of all recent workers on the subject. According to these authors the outwardly directed peritoneal cul-de-sacs were developed for the reception of the lateral lobes of the liver as a result of the unusual lateral extension of the anterior chamber of the air-bladder and its apposition on each side to the external skin. They further stated (p. 296) that

> 'The possibility, however remote, that these anatomical features have no special physiological value, but are simply the necessary result of other structural modifications of undoubted utility, must also be kept in view. The relative shortness of the abdominal cavity in many Siluroids may have caused the lateral extension of the air-bladder and its consequent abutment against the external skin.'

Recently in connection with my work on the Siluroid fishes of India for a revised edition of 'Fishes' in the *Fauna of British India* series, I dissected a large number of specimens belonging to different genera of Indian Catfishes for elucidating the form of the air-bladder and the modifications undergone

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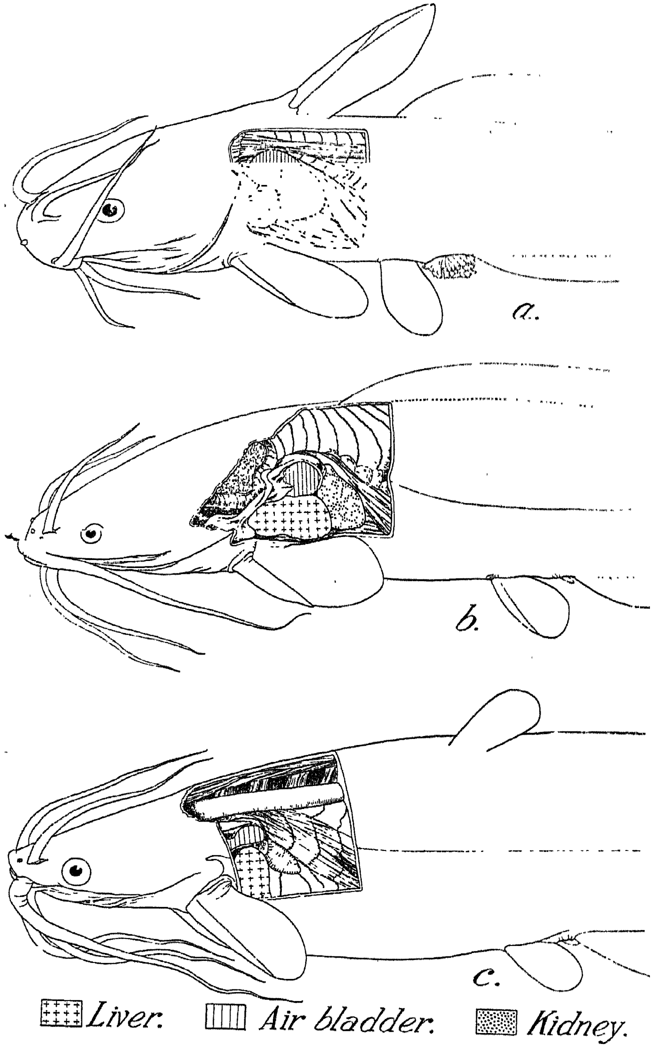


TEXT-FIG. 1.—Dorso-lateral view of the head and anterior part of the body of *Plotosus canius* Ham., *Clarias batrachus* (Linn.) and *Heteropneustes fossilis* (Bloch).

Skin in the region above the pectoral fin is removed to show the disposition of the liver, the air-bladder and the kidneys.

a. Plotosus canius Ham. × 1½; *b. Clarias batrachus* (Linn.). × ⅘; *c. Heteropneustes fossilis* (Bloch). Nat. Size.

by the associated skeletal structures. The disposition of the liver and the kidneys was also noted in each case, and it soon became apparent that the

chief factor that had brought about the peculiar disposition of the liver and the kidney in *Clarias*, *Heteropneustes*, etc. was undoubtedly the reduction of the body-cavity, while the actual formation of the extra-coelomic lobes appears to be due to the changes in shape and position of the air-bladder consequent upon the dorso-ventral flattening of the body.

In this note I trace the changes undergone by the air-bladder, the liver and the kidneys from the simple to the most highly specialized forms. As a result of the study of these types there seems little doubt that the remarkable modifications of the air-bladder, as elucidated by Bridge and Haddon in *Ailia* Gray, *Clupisoma* Swainson (=*Schilbeichthys* Bleeker), *Silonia* Swainson (= *Silundia* Cuv. & Val.), etc. are the direct result of the disposition of the liver and the kidneys and are not due to any special physiological requirements of the various forms.

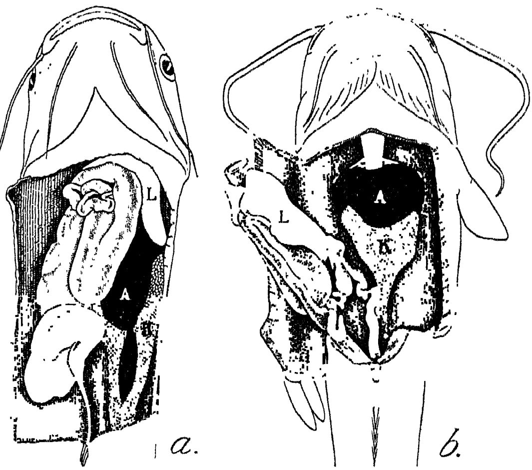
For the purpose of this enquiry Günther's (1864) divisions of the Siluroid fishes into Siluridæ Homalopteræ, Siluridæ Heteropteræ, Siluridæ Proteropteræ, and Siluridæ Proteropodes are of special significance, as they are based on the external extent of the dorsal and the anal fins; with these is also correlated the relative restriction in the size of the abdominal cavity in the various divisions. As the Siluridæ Proteropodes resemble the Siluridæ Proteropteræ in the form and extent of the anal fin, it will be sufficient to consider here the members of the first three groups only.

Among teleostean fishes, as a rule, the kidneys extend along the entire length of the dorsal wall of the abdomen, above the air-bladder: those of the two sides are partly fused with one another in the middle line. The anterior portion of each kidney is greatly dilated and, in the adult, consists of lymphatic or adenoid tissue only; as a result, while resembling the rest of the organ in external appearance, it cannot discharge any renal function. This persistent and usually bilobed 'head-kidney' occupies a recess of a corresponding shape lying in front of the anterior wall of the air-bladder. The liver, whose form is always closely adapted to that of the surrounding parts, lies to a greater or less extent beneath the intestinal tract.

The abdominal region in almost all Siluroid fishes is relatively short, the air-bladder extends at the sides and forms lateral cutaneous areas above the pectoral fins, the kidney is displaced from its normal position and caps the posterior part of the air-bladder, and the lateral lobes of the liver, which are displaced from their normal position, lie in peritoneal cul-de-sacs situated anterior to the lateral extension of the air-bladder.

With the forward extension of the anal fin, the body-cavity becomes still further reduced and as a result two organs, the kidney and the liver, encroach on the space usually occupied by the air-bladder. As a generalized example of the Siluridæ Heteropteræ we may consider the case of the genus *Pangasius* Bleeker which possesses a comparatively short anal fin. In very young specimens of *Pangasius pangasius* (Ham.), below 50 mm. in length, the air-bladder is extensive and its posterior portion in the form of a small hollow

knob-like protuberance lies embedded in the tissues of the kidneys ; this part of the air-bladder represents the portion of the structure that has been squeezed from all sides to provide more space for the kidney. With the growth of the fish the knob-like structure develops into a tubular cæcum and in the adult the air-bladder consists of an anterior large, oval chamber in which the length is greater than the breadth and a posterior long cæcum, constricted in one or more places, extending to the base of the caudal fin.[1] The portion of the cæcum in the abdominal cavity, or in the earlier stages the whole of it, is



TEXT-FIG. 2.—Dissection of the visceral organs of *Pangasius pangasius* (Ham.) and *Silurus cochinchinensis* Cuv. & Val., to show the disposition of the liver (L), the kidneys (K) and the air-bladder (A).

a. Pangasius pangasius (Ham.) × ⅘ ; *b. Silurus cochinchinensis* Cuv. & Val. Nat. Size.

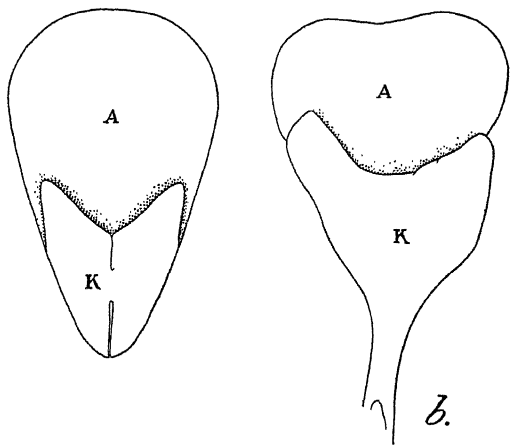
surrounded by the kidneys which also extend laterally at the sides of the anterior chamber. This condition has no doubt resulted from the fact that as the kidneys assumed their normal dimensions they pressed on the air-bladder for more and more space and towards maturity the pressure on the bladder seems to have been so great that a portion of it actually penetrated the muscles of the caudal region to ease the pressure for space in the abdominal cavity. Indian genera of the Siluridæ Heteropteræ may be grouped into three families—Schilbeidæ comprising *Pangasius, Pseudeutropius* Bleeker, *Silonia, Clupisoma, Eutropiichthys* Bleeker and *Ailia* ; Siluridæ comprising *Wallago* Bleeker, *Callichrous* Ham., and *Silurus* Linn., and Heteropneustidæ[2] containing

[1] This also happens in certain species of the genus *Cryptopterus* Bleeker (Family Siluridæ).

[2] Regan (1911) included this in the family Clariidæ, but I (1936 *a*) have given reasons elsewhere that this genus is closely related to the Siluridæ and on account of its special features should be regarded as the type of a distinct family.

Heteropneustes. The last two families and the Siluridæ Homalopteræ are considered first.

According to the general body-form, the Siluridæ may be divided into two sections, (i) in which the body is greatly compressed, such as *Wallago* and *Callichrous*, and (ii) in which the trunk region is at least moderately depressed, such as *Silurus*. In the first two genera the air-bladder is co-extensive with the abdominal cavity ; it is deeper than broad and the lateral walls of its anterior part lie just beneath the skin. The kidneys cap a consider-

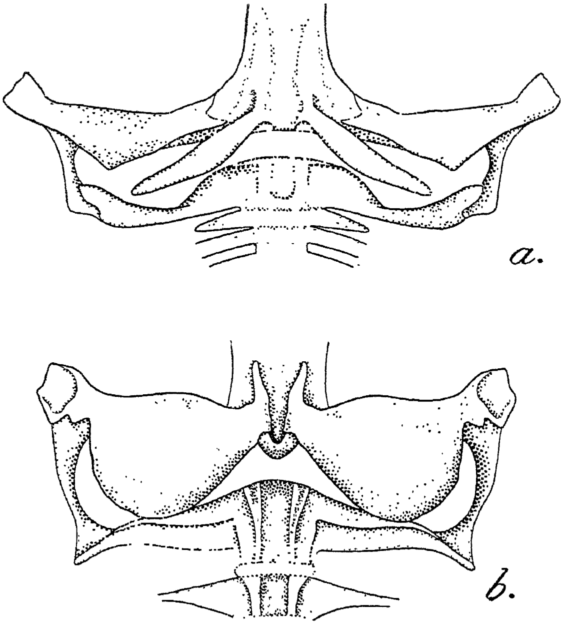


TEXT-FIG. 3.—Air-bladder (A) and Kidneys (K) of *Wallago attu* (Bloch) and *Silurus cochinchinensis* Cuv. & Val.

a. Wallago attu (Bloch). $\times 1\frac{3}{8}$; *b. Silurus cochinchinensis* Cuv. & Val. $\times 2\frac{2}{3}$.

able part of its posterior portion. In *Silurus,* however, the air-bladder occupies only one-third of the length of the abdominal cavity and is broader than long. It is thick-walled, thereby showing that its utility is partly lost. The kidneys are fairly extensive and are broadened anteriorly into a cup-shaped structure in which is lodged the posterior part of the bladder. The liver (text-fig. 2 *b*) is also very extensive, especially on the left side, and lies closely pressed against the air-bladder. In *Olyra* McClelland, an aberrant genus for which I (1936) have proposed a separate family, the air-bladder, though very similar to that of *Silurus,* is still further reduced. The disposition of the liver and the kidneys is very similar to that of *Silurus,* except that the kidneys now extend almost to the areas of the skin beneath which lie the lateral walls of the air-bladder.

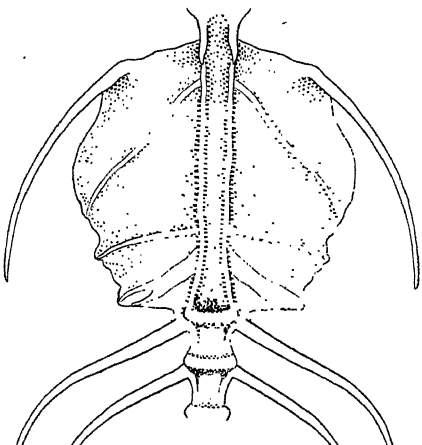
If a *Silurus*-like fish were to become greatly depressed, the space inside its body-cavity will be correspondingly reduced, and the forward push of the kidneys would result in the air-bladder assuming a transverse, tubular form, while to combat the forward thrust of these organs the bony elements would be developed in front of the air-bladder. Even in *Olyra* the beginnings of a



G. 4.—Air-bladder (unshaded portion) and associated skeletal structures in *Clarias batrachus* (Linn.) and *Heteropneustes fossilis* (Bloch).

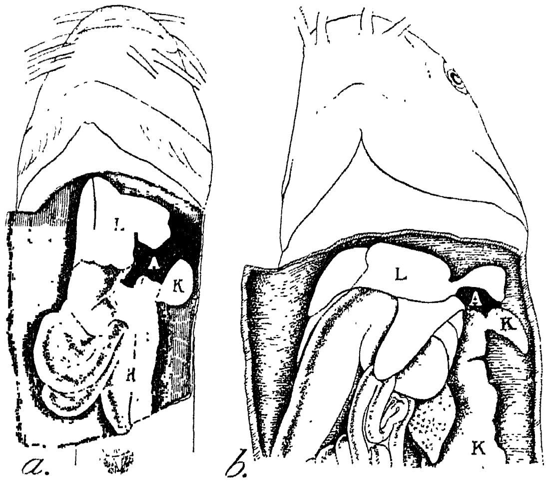
a. Clarias batrachus (Linn.). × 4 ; *b. Heteropneustes fossilis* (Bloch). × 4.

protective bony capsule are to be seen in the wing-like expansions of the transverse processes of the complex vertebra which partly envelop the anterior



TEXT-FIG. 5.—Wing-like expansions of the transverse processes of the complex vertebra in *Olyra longicaudata* McClelland. × 7.

part of the bladder. In the hypothetical case taken above, the forward growth of the kidneys, however, would be checked by the air-bladder and its bony capsules. The liver would also be able to extend laterally along with the bladder and come to lie ventral to it, beneath the skin in small extra-coelomic cul-de-sacs. Owing to the space required for the liver, anterior to the bony elements, the 'head-kidneys' would also be displaced from their normal position and pushed outwards round the posterior part of the air-bladder. Such series of changes have, in my opinion, brought about the peculiar dis-



TEXT-FIG. 6.—Dissection of the visceral organs of *Plotosus canius* Ham. and *Heteropneustes fossilis* (Bloch), to show the disposition of the liver (L), the air-bladder (A) and the kidneys (K).

a. Plotosus canius Ham. × $\frac{3}{4}$; *b. Heteropneustes fossilis* (Bloch). × $1\frac{1}{4}$.

position of the liver and the kidneys in *Heteropneustes* (text-fig. 1 *c*).

It is clear from the above that with the reduction of the body-cavity the kidneys encroach upon the space normally occupied by the air-bladder and thus set up a series of changes which result ultimately in the extrusion of small lobes of the liver and the kidneys into extra-coelomic spaces. With regard to the displacement of the liver, Bridge and Haddon have already noted (1893, p. 226) that

'In nearly all Siluroids the lateral growth of the air-bladder, and the intimate relation of its outer walls to the lateral cutaneous areas, have led to the displacement of the lateral lobes of the liver and their enclosure within peritoneal cul-de-sacs, a condition which sometimes persists even in cases where the air-bladder has undergone partial atrophy.'

Dutta (1924) showed that the extra-coelomic kidney in *Clarias* and *Heteropneustes* is devoid of any uriniferous tubules, Malpighian capsules and glomeruli and concluded that these facts 'definitely and clearly indicate that this portion of the kidney is a non-functional and degenerate organ'. Evidently he appears to have overlooked the fact already referred to above (*supra*,

p. 33) that in all teleostean fishes the anterior end of the kidney is usually converted into adenoid or lymphatic tissue, and though resembling the rest of the organ, it does not discharge a renal function. It has also been noted above that the 'head-kidney' only is pushed outwards into the extra-coelomic sacs. The modified lymphatic tissue of the 'head-kidney' probably discharges some very vital functions, as in spite of the lack of space for the extension of the kidney proper, it is being retained as a fairly large structure. In this connection it is very significant to note that the extra-coelomic portion of the liver has probably undergone no degeneration, as it was found by Dutta to be histologically exactly similar to the normal portion of the liver inside the body-cavity.

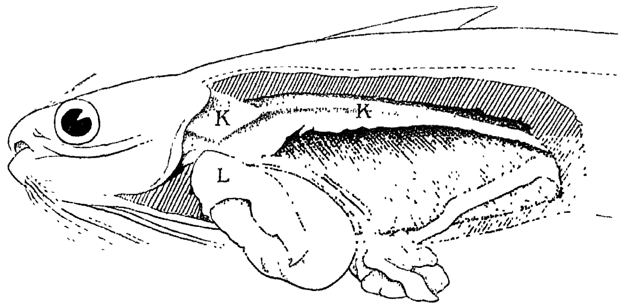
The Siluridæ Homalopteræ may next be considered. These forms, besides showing an antero-posterior reduction of the body-cavity, are characterized by the greatly depressed form of the body, similar to that of *Heteropneustes*. The three Indian genera of this division—*Chaca* Gray, *Plotosus* and *Clarias*, are now regarded as belonging to three different families which probably have no genetic affinity with one another. *Chaca*, with a greatly depressed form, has a relatively much more spacious body-cavity; the disposition of the air-bladder, the liver and the kidneys in this genus is similar to that of *Silurus*. In *Plotosus* (text-fig. 1 *a*) the bladder is considerably reduced, is broader than long and its lateral walls lie beneath the skin. As usual the kidneys cap its posterior portion, while lobes of the kidneys (presumably the 'head-kidneys') extend laterally along the bladder and come to lie beneath the skin. The liver also caps the anterior part of the bladder and sends out broad lateral flaps, which in younger specimens come to lie beneath the skin. In *Clarias* (text-fig. 1 *b*) the disposition of the liver, the kidneys and the air-bladder is very similar to that described above for *Heteropneustes*. As in the latter genus the air-bladder of *Clarias* also is in the form of a fairly wide, horizontal tube which is partially enclosed in bone (text-fig. 4 *a*).

So far I have considered the modifications undergone by the air-bladder, the kidneys and the liver consequent upon the reduction of the abdominal cavity both antero-posteriorly as well as vertically. During these changes the organs could only extend laterally into the muscles of the anterior region of the body wall. In the Schilbeidæ the reduction of the body-cavity is effected through the compression of the body, resulting in the specialized genera of the family assuming a Clupeid form in which the body is greatly compressed and the ventral surface almost forms a sharp keel. *Pangasius*, to which a reference has been made above (*supra*, p. 3), is, in my opinion, a generalized representative of the family Schilbeidæ, so we may start our series with that genus. In the course of evolution this genus, as I have shown elsewhere,[1] gave rise to

[1] In my revision of the Indian Schilbeidæ to be published in the *Records of the Indian Museum* for 1937 I have discussed the systematic position of *Pangasius* and shown the evolution of most of the other genera from this generalized type.

very diverse forms. Some of these are discussed below. In *Pseudeutropius,* as also in *Eutropius* Müll. & Trosch., *Schilbe* Cuv. and *Silurandon* Bleeker of Africa, the air-bladder is fairly extensive, in some forms it is co-extensive with the abdominal cavity while in others it is of the same nature as in *Silurus, Olyra,* etc., and the disposition of the liver and the kidney is also similar to that of either *Wallago* or *Silurus* (*vide supra,* p. 35). In certain species the lateral walls of the anterior portion of the bladder come to lie just beneath the skin and are to be distinguished externally as translucent, blister-like areas above the pectoral fins ; while in other forms the bladder is fairly thick-walled and occupies only one-quarter to one-half the length of the body-cavity.

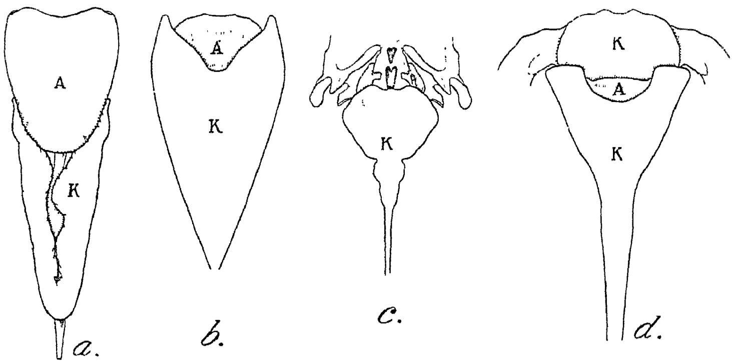
As the body-cavity became more and more reduced antero-posteriorly, as also laterally, important adjustments occurred in the disposition of the air-bladder, the kidneys and the liver. In *Clupisoma,* for instance, the normal kidneys not only pushed the air-bladder forwards but are also extended over its ventral surface. The ' head-kidneys ', which were displaced from their normal



TEXT-FIG. 7.—Dissection of the visceral organs of *Clupisoma garua* (Ham.), to show the disposition of the liver (L) and the kidneys (K). × $1\frac{1}{3}$.

position, form lateral lobes at the sides of the kidneys within the coelomic cavity. Further, owing to the great reduction of the body-cavity in its ventral portion the liver was displaced into the dorsal portion of the cavity, and presses the air-bladder from below. Under these circumstances the air-bladder of *Clupisoma* became greatly reduced and flattened. In some other genera, however, such as *Silonia, Eutropiichthys* and *Ailia,* the liver appears to have exerted more pressure on the air-bladder from below and the normal kidneys pushed it from behind so that it became greatly reduced and its central area became more or less solid or disappeared altogether. In young specimens of *Silonia* the air-bladder consists of a small, rounded structure with the normal kidneys capping its posterior part and the liver making a fairly broad depression in its middle. With the growth of the fish the kidneys extend forwards and the liver impinges on the air-bladder from below with the result that the bladder ultimately becomes divided into two portions, slightly united anteriorly, which come to lie in deep recesses formed in the transverse processes of the

complex vertebrae. The 'head-kidneys' are in their normal position anterior to the air-bladder. In *Eutropiichthys* the air-bladder is tubular and horse-shoe-shaped, but its posterior part is covered by the kidneys which provide a wide depression on the ventral surface for the liver. Even here the 'head-kidneys' are in their normal position. In *Ailia*, the most highly compressed fish among the Indian Schilbeidæ, the tubular, and horse-shoe-shaped air-bladder is covered anteriorly by the 'head-kidneys' and posteriorly by the normal kidneys which extend on the sides and occupy a considerable area in front of the posterior boundary of the air-bladder. Only a small portion of the air-bladder, however, is seen between the kidneys. The anterior part of the air-bladder is covered by a bony structure which now separates the 'head-



TEXT-FIG. 8.—Disposition of the kidneys (K) and the air-bladder (A) in certain Indian genera of the Schilbeidæ.

a. Pangasius pangasius (Ham.), half-grown specimen with a portion of the air-bladder extending into the caudal region. × ?; *b. Silonia silundia* (Ham.), young specimen, 135 mm. in total length. × $1\frac{3}{4}$; *c. Eutropiichthys vacha* (Ham.), young specimen, 140 mm. in total length. × $1\frac{1}{4}$; *d. Ailia coila* (Ham.), half-grown specimen, 88 mm. in total length. × $3\frac{1}{4}$.

kidneys' from the vital part of the bladder itself. Though *Ailia* and *Eutropiichthys* are probably not very closely related forms, the similarity in the structure of their air-bladder appears to have been induced by similar circumstances.

Reference may here be made to an extra-Indian form, the Siamese genus *Platytropius* Hora,[1] as it exhibits remarkable modifications. I have shown that its air-bladder is greatly flattened dorso-ventrally and has assumed a more or less leaf-like form.[2] The kidneys in this case lie in their normal position dorsal to the air-bladder but are greatly flattened. The 'head-kidneys' are situated in their normal position.

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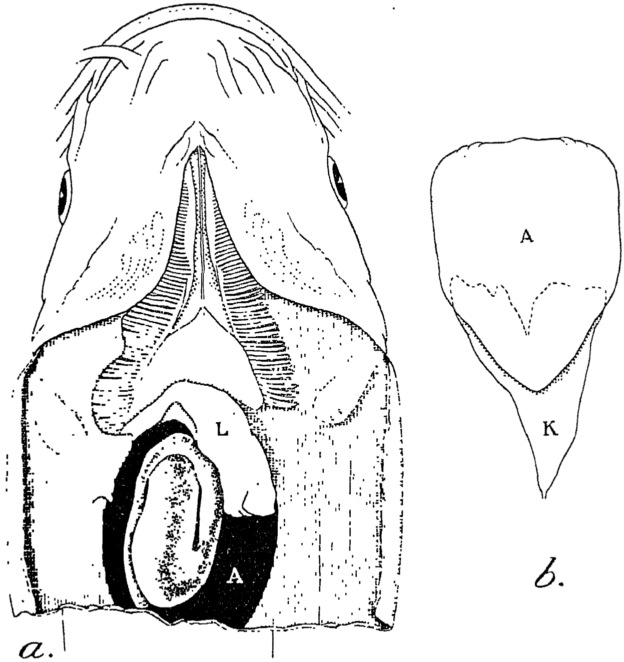
1 Genotype: *Pseudeutropius siamensis* Sauvage. This new genus will shortly be described in the *Journal of the Siam Society*, Natural History Supplement.

2 In *Osteogeniosus*, in which the air-bladder is more or less of the same type as that of *Platytropius*, the disposition of both types of kidneys is also similar.

From the modifications detailed above it is clear that for the peculiar disposition of the liver and the kidneys the initiative is provided by the forward extension of the caudal region and the consequent reduction of the space in the body-cavity. The necessary adjustments for the accommodation of the various organs in the reduced space are effected in various ways, mainly depending on the form of the body-cavity. In dorso-ventrally flattened forms there is a lateral extension of the organs, and the lateral portions of the air-bladder, the liver and the kidneys all come to lie just beneath the skin,



TEXT-FIG. 9.—*Platytropius siamensis* (Sauvage).

a. Dissection of the visceral organs to show the disposition of the liver (L) and the air-bladder (A). × 1½; *b.* Disposition of the air-bladder (A) and the kidneys (K). × 5¼. Dotted line represents the extent of the kidneys dorsal to the air-bladder or the portion of the kidneys covered by the air-bladder on the ventral surface.

as in *Plotosus*, *Clarias*, *Heteropneustes*, etc. If, on the other hand, the body is compressed from side to side the kidneys may lie in their normal position under a very much flattened air-bladder as in *Platytropius*, or may gradually push the air-bladder forwards till the latter, unable to expand laterally, becomes reduced to form a narrow horse-shoe-shaped tube, as in certain genera of the Schilbeidæ. I am of opinion that no special physiological value can be attached to these anatomical features which are obviously the result of a morphological adjustment consequent upon the reduction of the abdominal cavity. The air-bladder does not appear to be an organ of primary importance in the economy

of life of these fishes, and whenever more space is required, either for the liver or the kidneys, nature provides it at the expense of the air-bladder.

Summary.

The present views with regard to the peculiar disposition of the liver and the kidney are given and it is indicated that though no satisfactory solution of the problem has yet been suggested, the shortening of the body-cavity has been assumed to be the main cause both by Bridge and Haddon and Dutta, whereas Weber attributed the peculiarities to the lateral expansion of the air-bladder.

Günther's system of classification of the Siluroid fishes has been followed in this article as a matter of convenience. Generally in the Siluroid fishes the body-cavity is small and the liver and the kidneys are somewhat displaced from their normal position. In Siluridæ Heteropteræ, in which the dorsal fin is short and the anal fin long, the changes in the form and disposition of the air-bladder, the liver and the kidneys are dealt with in a progressive series from a primitive form like *Pangasius* to such highly specialized genera as *Clupisoma, Eutropiichthys* and *Ailia* of the Schilbeidæ and *Heteropneustes* of the Heteropneustidæ. The changes due to compression and depression of the body are shown to be of a very different nature; in the Schilbeidæ, in which the body is compressed, the air-bladder becomes greatly reduced and in extreme cases forms a horse-shoe-shaped tube, the functional kidneys may, wholly or partly, extend over the reduced air-bladder, while the liver is pushed upwards and presses on the air-bladder. In Heteropneustidæ, in which the body is depressed, the air-bladder assumes the form of a fairly wide transverse tube which extends laterally to the skin; along with the air-bladder, the liver and the kidneys also extend laterally and come to lie beneath the skin on the two sides of the air-bladder. In the three Indian genera of the Siluridæ Homalopteræ, *Chaca, Plotosus* and *Clarias*, the body is greatly depressed; their air-bladder, kidneys and liver show a series of changes leading to the condition described in the Heteropneustidæ. Reference is also made to the modifications observed in *Platytropius*, a Siamese genus.

It is concluded that the main cause of these modifications is the shortening of the body-cavity and the subsequent adjustment of the organs within the short space available.

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Catfishes of the Genus *Helicophagus* Bleeker.

By

SUNDER LAL HORA

CALCUTTA:

SEPTEMBER,

CATFISHES OF THE GENUS *HELICOPHAGUS* BLEEKER.

By Sunder Lal Hora, *D.Sc., F.R.S.E., F.N.I., Assistant Superintendent, Zoological Survey of India, Calcutta.*

It is generally recognised that the freshwater fish-fauna of India is very closely allied to that of south-eastern Asia, and, I[1] recently put forward the suggestion that it is in the main derived from that source. To elucidate the genetic affinities of some of the Indian forms it has, therefore, been necessary to study the morphological features of the related Far Eastern genera. For instance, in my work on the Siluroid fishes of India, Burma and Ceylon I found that though the accounts of the genus *Helicophagus* Bleeker clearly show its relationships to *Pangasius* Cuvier and Valenciennes, there are certain features in the anatomy of the latter by which it can be separated from the other Schilbeid fishes of south-eastern Asia and Africa; certain authorities[2] as a result regard it as a member of a separate. monotypic family Pangasiidae. The modern classification of Siluroid fishes is, in the main, based on Bridge and Haddon's[3] critical morphological studies of these fishes, especially of their air-bladder and the associated skeletal structures. Unfortunately these authors were for want of material not able to deal with all the forms of the family, and in most cases it was not possible for them to study the changes undergone during growth in various species. *Helicophagus* was one of the genera, of which they had no specimen for study, but they reported upon 5 species of *Pangasius*. Through the kindness of Mr. Luang Choola, Officer-in-charge, Bureau of Fisheries, Bangkok, I was able to obtain on loan a fine example of *H. waandersi* Bleeker for study. I have availed myself of this opportunity to examine as much of its anatomy as possible without impairing the utility of the specimen for museum purposes. I am very grateful to Mr. Luang Choola and the Bureau of Fisheries, Bangkok, for the loan of the specimen.

According to Weber and de Beaufort,[4] *Helicophagus* and *Pangasius* can be distinguished from each other with the help of the following key :—

" *a.* Posterior nostril between anterior one and eye; eye behind and totally above corner of mouth. No palatine teeth	*Helicophagus.*
b. Posterior nostril at short distance from anterior and above a line between anterior nostril and eye. Eye partly below a horizontal through the corner of mouth	*Pangasius.*"

[1] Hora, S. L.—Geographical Distribution of Indian Freshwater Fishes and its bearing on the probable land connections between India and the adjacent Countries. *Curr. Sci.*, V, pp. 351-356 (1937).

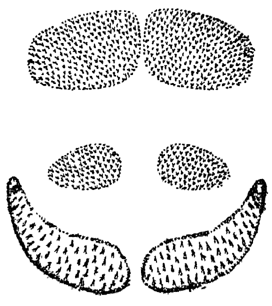
[2] Regan, C. Tate.—The classification of the teleostean fishes of the Order Ostariophysi. II. Siluroidea. *Ann. Mag. Nat. Hist.*, (8) VIII, pp. 553-557 (1911).

[3] Bridge, T. W. & Haddon, A. C.—Contribution to the anatomy of Fishes.—II. The Air-bladder and Weberian Ossicles in the Siluroid Fishes. *Phil. Trans. Roy. Soc. London*, (B) CLXXXIV, pp. 214-221 (1893).

[4] Weber, M. and de Beaufort, L. F.—*The Fishes of the Indo-Australian Archipelago.* II, p. 247 (Leiden, 1913).

In the above key no reference is made to the nature of the teeth in *Pangasius*, but in the description of the genus the authors state that the vomerine and the palatine teeth are "in 4 patches, or united into one, or only the vomerine patches united". I have examined the dentition of several species of *Pangasius* and find it to be very variable. In species like *P. hypophthalmus* (Sauvage), the dentition is feebly developed or altogether absent. In the development of *Pangasius pangasius* (Ham.) it has been found that the dentition of the species undergoes considerable changes. In the case of *Pangasius*, therefore, dentition is not a very safe diagnostic character. Presumably on the basis of dentition alone Sauvage[1] referred *P. hypophthalmus* to the genus *Helicophagus* and the same feature appears to have influenced Suvatti[2] in supporting Sauvage's view. It has, however, been shown by me[3] that in this species the posterior nostril is situated only slightly behind the anterior and above the line joining the middle of the eye to the anterior nostril. According to this character there is no doubt regarding its position in the genus *Pangasius*. Its broad head and snout also point to the same conclusion, for in *Helicophagus* the head is conical with a prominent, bluntly-pointed snout. Moreover, a part of its eye is situated below a horizontal line passing through the corner of the mouth.

After the elimination of *P. hypophthalmus* from *Helicophagus* there only remain 2 species of this interesting genus : *H. typus* Bleeker, known from Palembang in Sumatra and *H. waandersi* Bleeker, known from Palembang, river Batang Hari and Djambi in Sumatra, Siam and Indo-China. Thus this genus has a somewhat restricted distribution, whereas *Pangasius* is found throughout south-eastern Asia (including India), except Southern China and Ceylon.



TEXT-FIG. 1.—Dentition of *Helicophagus waandersi* Bleeker. × 7. Length of specimen 143 mm. without caudal.

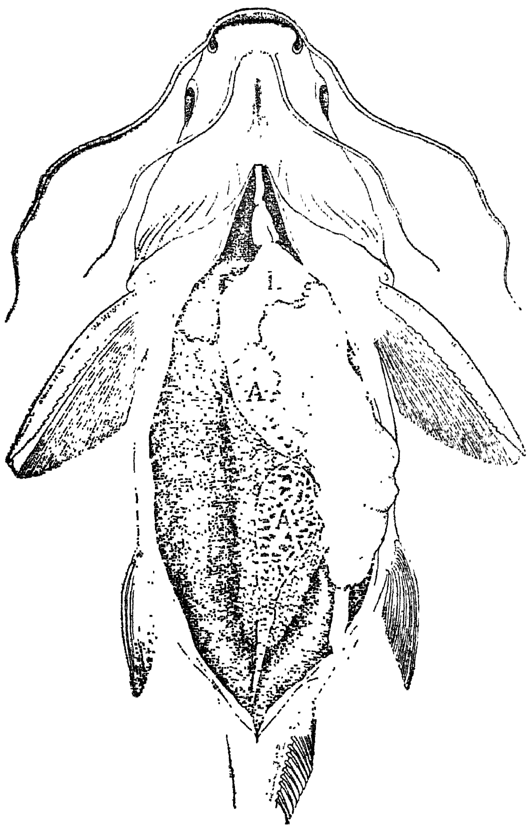
Comparing *Helicophagus waandersi* with several species of *Pangasius* that I have studied I find that the former possesses much longer barbels

[1] Sauvage, H. E.—Recherches sur la faune ichthyologique de l'Asie et description d' especes nouvelles de l'Indo-Chine. *Nouv. Arch. Mus. Hist. Nat. Paris,* (2), IV, p. 170 (1881).

[2] Suvatti, C.—*Index to Fishes of Siam,* p. 81 (Bangkok, 1936).

[3] Hora, S. L.—On a collection of fish from Siam. *Journ. Nat. Hist. Soc. Siam,* VI, p. 166 (1923).

and a very peculiar type of dentition. The teeth (text-fig. 1) of the upper jaw form two almost quadratic patches and those of the vomer are disposed in two small patches widely separated from one another. In the lower jaw the teeth are somewhat larger and fewer in number; they form two pear-shaped patches with the points directed outwards and backwards. In *H. typus*, however, the teeth in the jaws are stated to form broad, curved bands; while those on the vomer are arranged in two distinct, narrow, curved bands. There would thus appear to be considerable variation in the dentition of this genus.

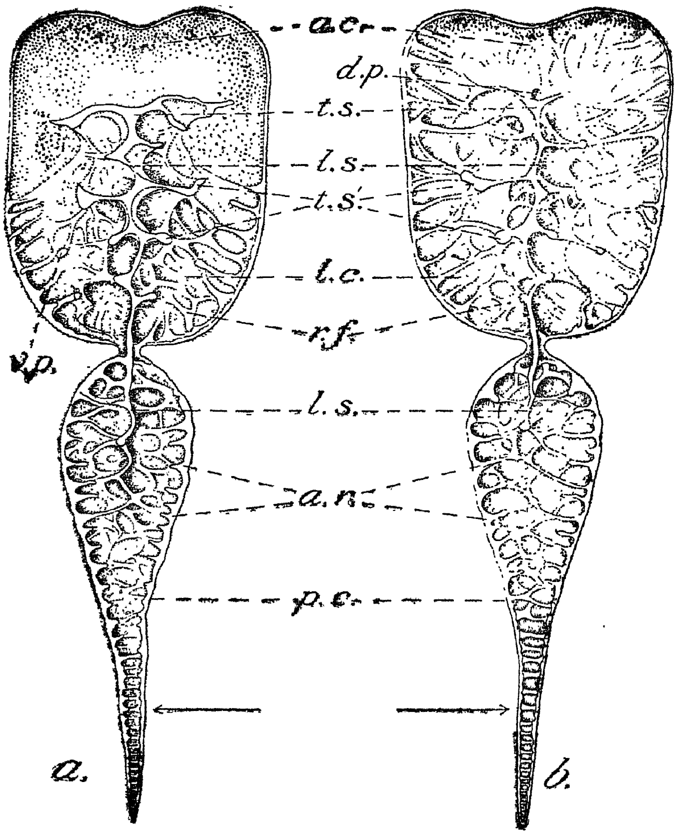


Text-fig. 2.—Dissection of the visceral organs of a specimen of *Helicophagus waandersi* Bleeker. $\times 1\frac{1}{3}$.
A. Air-bladder; **K.** Kidney; **L.** Liver.

To examine the disposition of the visceral organs of *H. waandersi* (text-fig. 2) an incision was made along the mid-ventral line. The positions of the liver, the kidneys and the air-bladder respectively were almost similar to those of *Pangasius pangasius*.[1] The lateral lobes of the liver

[1] Hora, S. L.—Correlation between the disposition of the Liver and the Kidney and the form of the Air-bladder in Certain Siluroid Fishes of India. *Proc. Nat. Inst. Sci. India*, III, p. 34 (1937).

are lodged in small cul-de-sacs above the pectoral fins, so that the liver lies very close to the skin. The air-bladder is divided into two portions, a large anterior portion corresponding to the normal air-bladder and a posterior portion which is drawn out in the form of a caecum. A small portion of the caecum extends into the muscles of the tail on the right



TEXT-FIG. 3.—Air-bladder of a specimen of *Helicophagus waandersi* Bleeker, 143 mm. in length without the caudal, showing the internal structure. ×2⅝.

a. Dorsal half; *b.* Ventral half.

a. c. Anterior chamber; *a. r.* Annular ridges; *d. p.* Pneumatic duct; *l. c.* Lateral chamber; *l. s.* Longitudinal septum; *p. c.* Posterior chamber or caecum; *r. f.* Root-like fibres; *t. s.* Primary transverse septum; *t. s.'* Secondary transverse septa; *v. p.* Vertical pillar.

The part of the air-bladder below the arrows is enclosed in the muscles of the tail region.

side. In several respects the bladder is similar to that of a specimen of *Pangasius pangasius* of the same size (143 mm. in length without caudal).

The internal structure of the air-bladder (text-fig. 3) is, in the main, similar to that of a specimen of *P. pangasius*[1] of the same size. The anterior portion of the bladder is divided internally by a primary transverse septum (*t. s.*) into a short and broad anterior chamber (*a. c.*) and a pair of lateral chambers (*l. c.*), separated from each other by a longitudinal septum (*l. s.*). The dorso-lateral walls of the anterior chamber bulge out dorsally so as to form pocket-like cavities which are lodged inside the recesses provided by the vertebral elements, one on either side of the vertebral column. The remaining portion of this chamber is invaded by fibrous growths of the primary transverse septum. The cavities of the lateral chambers are subdivided and broken up by the formation of numerous secondary transverse septa (*t. s'.*), which grow out from the sides of the longitudinal septum ; they do not, however, extend to the outer wall of the chambers. In the transverse cavities thus enclosed, the walls become greatly thickened and sacculated by the development of fibrous tissue (*r. f.*) so that the free space inside the bladder is greatly reduced. In addition to these fibrous growths, there are a few vertical pillars (*v. p.*) which make the air-bladder more compact.

The pneumatic duct (*d. p.*) opens into the bladder on its ventral wall in the middle line just in front of the transverse septum.

The posterior portion of the bladder (*p. c.*) communicates anteriorly with both the lateral chambers of the anterior portion, but terminates blindly behind. It is fairly broad anteriorly but from the middle of its length becomes very narrow and tube-like. The longitudinal septum noted above, extends into the caecum for a short distance. The walls of the caecum are greatly thickened throughout by the formation of annular ridges (*a. r.*).

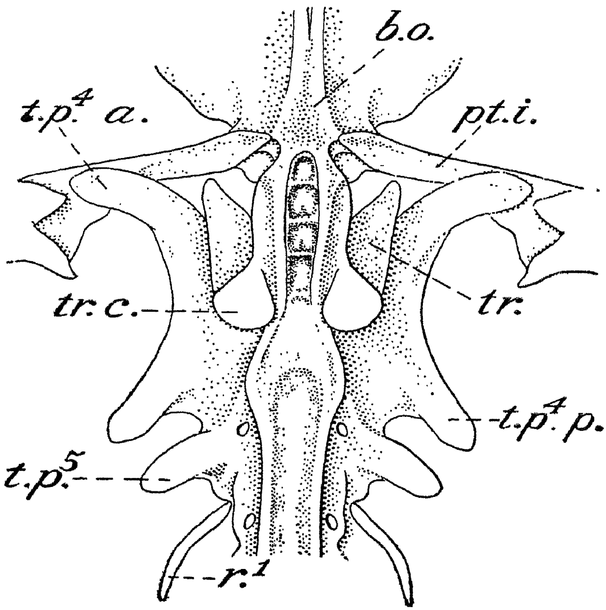
In the modification of the anterior vertebrae (text-fig. 4), *Helicophagus waandersi* differs from most of the species of *Pangasius*, but conforms to the normal condition in a great majority of the Siluroid fishes. Each of the transverse processes of the fourth vertebra has a broad flat root, which is prolonged distally into distinct anterior (*t.* p^4. *a.*) and posterior (*t.* p^4. *p.*) divisions, separated from each other by a broad, deep concavity. The anterior division is moderately thick and inflexible and does not possess any trace of the oval plate so characteristic of *Pangasius pangasius* and several other species of the genus. So in *Helicophagus* there is no "elastic-spring" mechanism ; the distal portion of the process is applied to and firmly supports the outer extremity of the inferior limb of the post-temporal (*pt. i.*). The structures described above correspond with those of *P. micronema* Bleeker, the only species of *Pangasius* in which Bridge and Haddon (*op. cit.*) did not find an "elastic-spring" mechanism, and which would in the circumstances appear to form a connecting link between the genera *Helicophagus* and *Pangasius*.

In *P. pangasius*, Nair (*op. cit.*) has shown that with the development of the fish the space inside the air-bladder is gradually reduced and in

[1] Nair, K. K.—Changes in the Internal Structure of the Air-bladder of *Pangasius pangasius* (Ham.) during Growth. *Rec. Ind. Mus.*, XXXIX, pp. 117-124 (1937).

It may, however, be noted that the air-bladder of a specimen of *Pangasius pangasius*, 143 mm. in length, does not extend into the muscles of the tail region ; the narrow portion of its caecum is devoid of annular ridges and the posterior portion is smaller than the anterior. The absence of an "elastic-spring" mechanism in *Heli cophagus* is referred to later.

large specimens a fatty degeneration of its tissues, especially at the anterior end, takes place. So far as the hydrostatic function of the



TEXT-FIG. 4.—Ventral view of the anterior vertebrae and their processes in a specimen of *Helicophagus waandersi* Bleeker, showing the absence of any "elastic-spring" mechanism. ×4.

b. o. Basioccipital; *pt. i.* Inferior process or limb of post-temporal; r^1. First rib; *t.* p^4. *a.* Anterior division of the transverse process of the fourth vertebra; *t.* $p.^4p$. Posterior division of the transverse process of the fourth vertebra; *t.* $p.^5$ Transverse process of the fifth vertebra; *tr.* Tripus; *tr. c.* Crescentic process of the tripus.

bladder is concerned it becomes less and less effective with growth. Owing to the competition for space inside the body cavity of forms with a long anal fin, the bladder is pushed from all sides and it seems to me that the modification of the anterior division of the transverse process of the fourth vertebra to form a plate is meant to check the forward growth of the bladder. It is because of this resistance at the anterior end that the bladder finds space for its extension in the muscles of the tail. The so-called "elastic-spring" apparatus is a primitive device, while the condition met with in *P. micronema*, *Helicophagus waandersi*, and in a majority of the other Siluroid fishes is of a more specialised nature.

From the foregoing considerations it would appear that *Helicophagus*, with long barbels, well-developed dentition, without an "elastic-spring" apparatus, etc., etc., is at a somewhat higher stage of evolution than *Pangasius*. There also seems no justification for separating *Pangasius* from the rest of the Schilbeidae only because of the presence of "elastic-spring" mechanism in a number of its species.

RECORDS

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INDIAN MUSEUM

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Notes on Fishes in the Indian Museum.

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SUNDER LAL HORA

CALCUTTA:
DECEMBER, 1937

NOTES ON FISHES IN THE INDIAN MUSEUM.

By SUNDER LAL HORA, *D. Sc., F. R. S. E., F. N. I., Assistant Superintendent, Zoological Survey of India, Calcutta.*

XXX.—ON THE SYSTEMATIC POSITION OF *CYPRINUS COSUATIS* HAMILTON.

Cyprinus cosuatis is one of the ten species assigned by Hamilton[1] to the eighth division—*Cabdio*—of the genus *Cyprinus* which comprises a very heterogenous assemblage of forms. The other species of this division are *C. jaya*, *C. mola*, *C. hoalius*, *C. borelio*, *C. solio*, *C. guganio*, *C. cotio*, *C. devario* and *C. dancena*. The generic name *Cabdio* is not in common use, but according to Jordan[2] its type should be the first species named, *i. e.*, *Cyprinus jaya* Hamilton. In view of this limitation it is likely that *Aspidoparia* Heckel[3], with *A. sardina* as orthotype may have to be suppressed in favour of *Cabdio*. Of the other species, *C. mola* is usually assigned to the genus *Amblypharyngodon* Bleeker, *C. cosuatis* and *C. guganio* to *Barbus* Cuvier, *C. cotio* to *Rohtee* Sykes, *C. devario* to *Danio* Hamilton, while the precise generic and specific limits of the remaining species are still in doubt. Of the two small species at present included in the genus *Barbus*, *B. guganio* is known only from Hamilton's original description and figure and so far as I am aware no specimen of the species is at present available in any museum collection, though according to Hamilton (*loc. cit.*, p. 339) " The *Guganio* (*Gugani*) is probably found in most of the rivers and ponds of the Gangetic provinces, as I have seen it in both the Brahmaputra and Yamuna, the extreme rivers of that territory." Day[4] considered it to be a close ally of his *B. ambassis*, which he found in " Madras, Orissa, Bengal, and Assam at least as high as Suddya." *Barbus cosuatis* was originally described from the Kosi river, but Day extended its range to " Bengal through the N. W. Provinces, the Deccan and Bombay, and down the Western coast as low as Cottayam in Travancore."

Among other characters Hamilton (*loc. cit.*) noted the following distinguishing features of his *Cyprinus cosuatis*:

> " The *form* is deep, compressed, more prominent on the back than below. The *colour* is silver, with a greenish back, and the scales on the part are dotted towards the root. The ventral fins are red, all the others are yellowish, and those of the back and behind the vent are stained with black. The eyes are silver, stained above with black."

Day (*loc. cit.*) who figured a specimen of the species from Jubbulpore, noted that the fish attains 2 to 3 inches in length and directed attention

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[1] Hamilton, F.—*An Account of the Fishes found in the River Ganges and its branches*, pp. 333-343 (Edinburgh : 1822).

[2] Jordan, D. S.—*The Genera of Fishes*, p. 115 (Stanford University, California : 1917).

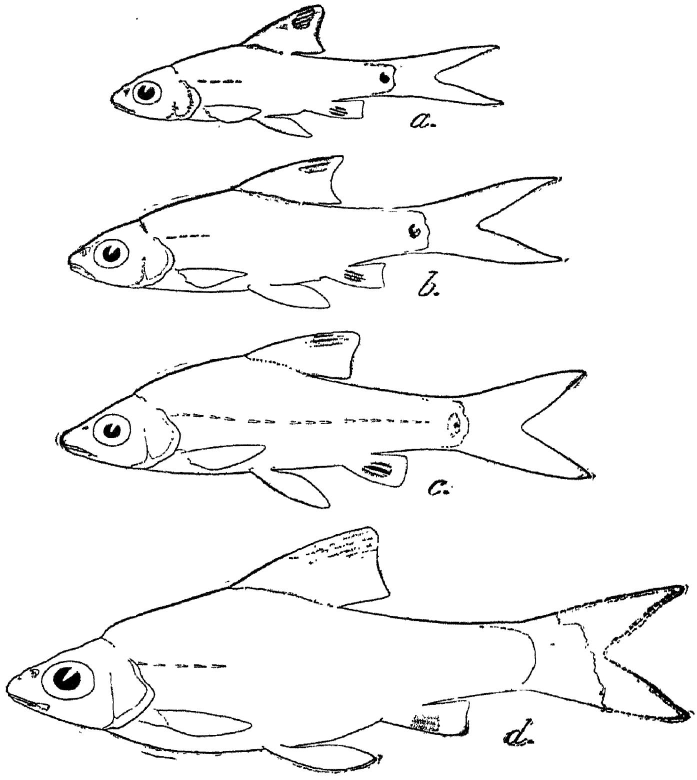
[3] Heckel, J. J.—Ichthyologie (von Syrien). In Russegger (Joseph von) : Reisen in Europe, Asien und Africa, mit besonderer Rücksicht aufnaturwissen schaftlichen Verhältnisse der betreffenden Länder, unternommen in den Jahren 1835 bis 1841. Part 2, p. 288 (1877).

[4] Day, F.—*Fishes of India*, pp. 576, 579, 581 (1877).

to several of its salient features. Among these mention may be made of the following, (i) dorsal without any osseous ray, (ii) height of dorsal greater than depth of body, (iii) incomplete lateral line, (iv) scales along lateral line larger than others, (v) 8 or 9 rows of scales before base of dorsal and (vi) colouration. Recently in a specimen of the species from Mysore I[1] pointed out the greater extent of the lateral line and the well defined nature of the rounded black spots on the dorsal and the anal fins. Further it was observed that:

"The most remarkable feature of this species appears to be the presence of numerous, fine, parallel sensory folds on the sides of the head. This feature it shares with the fishes of the genus *Cyclocheilichthys* Bleeker, but in other respects it is quite different."

Later I found that Smith[2] had already described a new genus *Oreichthys* from Siam for Cyprinid fishes of the type of *Barbus cosuatis* and



TEXT-FIG. 1.—Outline drawings of the growth-stages of *Oreichthys cosuatis* (Ham.).

a. 18 mm. in length without caudal; *b*. 23 mm. in length without caudal; *c*. 26 mm. in length without caudal; *d*. 34 mm. in length without caudal.

[1] Hora, S. L.—Notes on Fishes in the Indian Museum, XXVIII. On three collections of Fish from Mysore and Coorg, South India. *Rec. Ind. Mus.*, XXXIX, pp. 17, 18 (1937).

[2] Smith, H. M.—Contributions to the Ichthyology of Siam, III. A New Genus and New Species of Cyprinoid Fishes. *Journ. Siam Soc., Nat. Hist. Suppl.*, IX, p. 63 (1933).

had assigned to it a new species *O. parvus*, which is said to grow to 31 mm. in total length. In general facies, lepidosis and colouration the Siamese fish seemed so similar to Hamilton's *cosuatis* that I requested Mr. Luang Choola, Officer-in-charge, Bureau of Fisheries, Bangkok, to send me for comparison a few specimens of Smith's species. He very kindly presented 3 examples of *O. parvus* to the Zoological Survey of India, and these have enabled me to come to a definite conclusion that *O. parvus* is a juvenile form of *Cyprinus cosuatis.* Further, it is clear that this species is sufficiently distinct, especially on account of the sensory folds on the head, from the numerous species of the genus *Barbus* known from India, and should, therefore, be retained in a separate genus *Oreichtys* Smith, which as pointed out by its author, is closely allied to *Cyclocheilichthys* Bleeker.

Oreichthys cosuatis (Ham.) is represented by a few specimens in the collection of the Indian Museum, and unfortunately most of them are not in a good state of preservation. The sensory folds on the head are, however, fairly distinct in all of them. A comparison with the young specimens from Siam shows that when the fish is about 18 mm. in length without the caudal fin (text-fig. 1 *a.*), the dorsal spine is longer than the head and the depth of the body, and the spot at the base of the caudal fin is intensely black. The spots on the dorsal and the anal fins are also well marked and seem quite compact. In a specimen about 23 mm. in length without the caudal (text-fig. 1 *b*) the depth of the body is almost equal to the length of the dorsal; the length of the head is considerably shorter than both these dimensions. The three colour spots are somewhat diffuse but more extensive. In a specimen from Mysore, about 26 mm. in length without the caudal (text-fig. 1 *c*), the depth of the body is considerably greater than the length of the dorsal fin, which is almost equal to the length of the head. The dorsal and the anal fin spots are well pronounced, while that at the base of the caudal fin is very diffuse and indistinctly marked. The most remarkable feature about this specimen is that the lateral line, though interrupted in places, extends up to the 20th scale. As a rule, it is present only on the first 4 or 5 scales. In a specimen from the Saran District of Bihar, about 34 mm. in length without the caudal (text-fig. 1 *d*), the length of the dorsal fin, though greater than that of the head, is considerably shorter than the depth of the body. The spot on the dorsal fin is very diffuse and extensive while that on the anal fin is only faintly marked. As far as I can make out from the spirit material, the spot at the base of the caudal fin is almost absent.

Though sufficient material is not available for a detailed study of the variations undergone by this fish with growth, it is clear from the above that the young specimens from Siam are referrable to Hamilton's species.

XXXI.—ON A SMALL COLLECTION OF FISH FROM SANDOWAY, LOWER BURMA.

In the course of an investigation of the Anopheline fauna of Sandoway, Lieut. E. S. Feegrade, Malariogist to the Public Health Department of Burma, collected several samples of fish from the stone-lined

shallow wells and the road-side drains of the town of Sandoway, head-quarters of the district of the same name in Lower Burma and situated in Lat. 18° 28′ N. and Long. 94° 21′ E. The fish were collected in several lots between June and August 1936, and sent to the Zoological Survey of India for determination. At my request, Lieut. Feegrade arranged to have further specimens collected through Dr. U. Shwe Baw for the Zoological Survey of India. Though the entire material consists of 24 specimens only, two new species have been discovered. It has also been found that the specimens of the already known species vary considerably from their respective typical series, especially in colouration. These results are not surprising when it is remembered that the fresh-water fish fauna of this region, including that of the neighbouring Arakan Yomas. has never been investigated before.

Lieut. Feegrade informed me that most of his material was collected in clear, running water, such as road-side drains, seepage water drains, small hill-streams and small ponds. It may be indicated that Sandoway is situated on the left bank of the Sandoway river, about 15 miles to the S. E. of its mouth and between 4 to 5 miles due east of the sea coast in a direct line. The area in its neighbourhood is full of tidal creeks and there is practically no plain land along the valley of the Sandoway river.

The following species of fish have been found in the collection :—

1.	*Rasbora daniconius* (Ham.)	2 specimens.
2.	*Brachydanio choprai* Hora	4 specimens.
3.	*Danio feegradei*, sp. nov.	1 specimen.
4.	*Barbus* (*Puntius*) *binduchitra*, sp. nov.	10 specimens.
5.	*Barbus* (*Puntius*) *stoliczkanus* Day	5 specimens.
6.	*Panchax panchax* (Ham.)	2 specimens.

I take this opportunity to offer my sincere thanks to Lieut. E. S. Feegrade for having made a valuable collection of fish for the Zoological Survey of India. The material is in a very good state of preservation.

Rasbora daniconius (Ham.).

1889. *Rasbora daniconius*, Day, *Faun. Brit. Ind. Fish.*, I, p. 336.

Rasbora daniconius is represented in Lieut. Feegrade's collection by two specimens, measuring 42 mm. and 45 mm. in total length. They were collected from a road-side drain. The black lateral band is very well marked and extends from the tip of the snout to the base of the caudal fin, the middle rays of which are stained gray. The scales above the lateral line, as also some below it, are marked with black dots along the margin. The dorsal surface is dusky with a black streak along the mid-dorsal line.

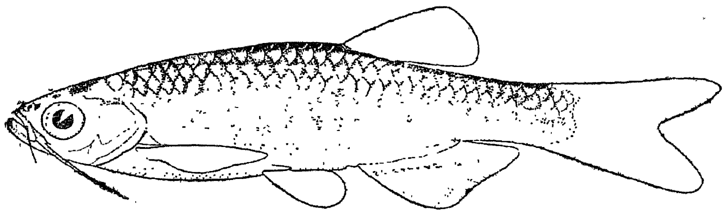
Brachydanio choprai[1] Hora.

1928. *Danio* (*Brachydanio*) *choprae*, Hora, *Rec. Ind. Mus.*, XXX, p. 39, fig.2.
1934. *Danio* (*Brachydanio*) *choprae*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVI, p. 130 (Synoptic Table to species of *Brachydanio*).

There are 4 specimens of *Brachydanio choprai* from Sandoway ; 2 were collected from a stone-well, while the remaining two were obtained

[1] By mistake *e* instead of *i* had been previously used in the termination of this specific name. The species was named after my colleague Dr. B. N. Chopra.

from a road-side drain. The two examples, 28 mm. and 30 mm. in total length respectively, from the well are more or less devoid of the typical colour pattern of the species, while those collected from the drain, 33 mm.



Text-fig. 2.—Outline sketch of *Brachydanio choprai* Hora, showing colour markings in a specimen 33 mm. in total length.

and 36 mm. in total length respectively, are very gorgeously coloured. In the larger specimens the anterior vertical bands are replaced by rows of spots at the posterior end. The bands on the dorsal and the caudal fins are either faintly marked or are absent altogether. The band on the anal fin is, however, present in all the specimens.

There are several large sensory pores on the dorsal surface of the head along the supra-orbital edges. Though. as a rule, the lateral line is absent in this species, in certain specimens it may be present on the first few scales ; when present, it bends abruptly downward and may extend as far as the base of the pelvic fin.

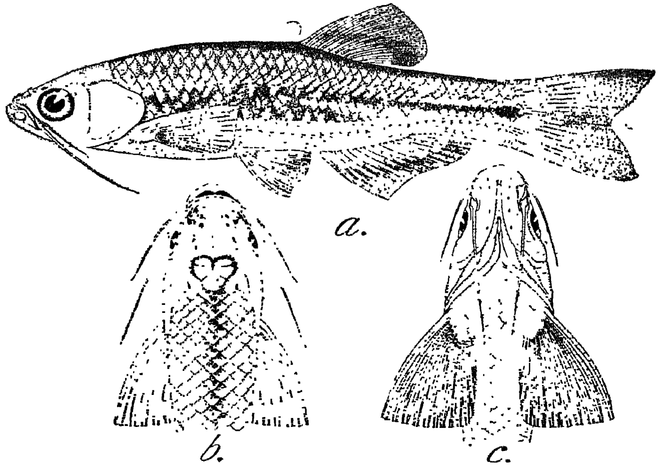
The species was hitherto known only from the Myitkyina District of Upper Burma.

Danio feegradei, sp. nov.

D. 2/9 ; A.3/12 ; P.12 ; V.8 ; C.19 ; L.l.39 ; L.tr.$7\frac{1}{2}/2\frac{1}{2}$.

The new species possesses a graceful form with both the dorsal and the ventral profiles slightly arched. The head and body are greatly compressed. The head is bluntly pointed and its length is contained 4·9 times in the total length and 3·9 times in the length without the caudal. The height of the head at the occiput is contained 1·3 times, and its width 1·8 times in its length. The diameter of the eye is contained about 3·3 times in the length of the head, 0·9 times in the length of the snout and 1·2 times in the interorbital distance. The nostrils are situated close to the anterior margin of the eye ; the anterior nostril is somewhat tubular. Inner to the upper margin of the eye is a series of 4 large sensory pits similar to those described above in the case of *Brachydanio choprai.* Similar pores are also present on the ventral surface of the head. The mouth is small and oblique ; it extends to below the anterior margin of the eye. The lips are thin, but are somewhat better developed near the angles of the mouth. Inner to the lower lip, on either side, there is a small pad of skin covered with spinous outgrowths. Presumably these structures represent the secondary sexual character of the male. There are two pairs of barbels ; the rostrals are considerably shorter than the head, while the maxillary barbels are almost as long as the head or slightly longer. The basal portion of the rostral barbel is enclosed in a groove.

The depth of the body at the commencement of the dorsal fin is equal to the length of the head. The least height of the caudal peduncle



TEXT-FIG. 3.—*Danio feegradei*, sp. nov.
a. Lateral view. $\times 1\frac{1}{2}$; *b.* Dorsal surface of head and anterior part of body. $\times 2$.

is contained 1.5 times in its length. The lateral line is complete and runs along the lower half of the caudal peduncle. There are about 39 rows of scales along the lateral line and $7\frac{1}{2}$ rows between it and the base of the dorsal fin. There are $2\frac{1}{2}$ rows of scales between the lateral line and the base of the pelvic fin which is provided with a scaly appendage. There are about 20 predorsal scales and 14 round the caudal peduncle. There are a few rows of small scales at the base of the anal fin.

The dorsal fin is short; its commencement is equidistant between the posterior margin of the eye and the base of the caudal fin; its height is considerably less than the depth of the body below it. The pectoral fin is smaller than the head and just reaches the base of the pelvic fin. The pelvic fin extends to the anal opening, but not to the anal fin. The anal fin is fairly extensive; the length of its base is equal to the head without the snout. The caudal fin is somewhat longer than the head, it is emarginate, with the upper lobe slightly longer than the lower.

The general ground colour, after preservation in spirit, is pale-olivaceous. The dorsal surface is dusky with a black streak along the mid-dorsal line. In the middle of the fish there is a black band which is considerably broader anteriorly and terminates posteriorly in a somewhat darker spot at the base of the caudal fin. Anteriorly the black band is marked, both above and below, with short pearl-white bands and in the posterior region there is a white longitudinal band above it. The rays of the dorsal and anal fins are marked with longitudinal bands across them.

Type-specimen.—F. 12477/1, Zoological Survey of India, Indian Museum, Calcutta.

Habitat.—Road-side drains, Sandoway, Lower Burma.

Remarks.—In referring this species to the genus *Danio* Hamilton a certain amount of difficulty has been experienced. Weber and de Beaufort[1] restricted this generic denomination to fishes with "Dorsal fin elongate, with 12-16 branched rays. Lateral line complete." The remaining species, "With dorsal fin short, with 7 branched rays only. Lateral line incomplete or absent.", were referred to *Brachydanio.* In 1934, Mukerji and the writer[2] observed that

"During recent years several new forms of the *Brachydanio*-type have been discovered in Burma and though in all of them the dorsal fin is short, the lateral line has been found to be very variable. In the majority of forms it is either absent or extends over a few scales in the anterior region; but there are some species in which it is fairly extensive or even complete."

Danio feegradi has only 9 branched rays, as against 7 in *Brachydanio* and 12-16 characteristic of the other species of *Danio.* In this respect it is intermediate between the two genera; while in the possession of long barbels and a complete lateral line it shows greater affinities with the typical members of the *Danio* group. The colouration of this fish is quite different from other species of the genus known so far.

The name of this gorgeously coloured little fish is associated with that of Lieut. E. S. Feegrade.

Measurements in millimetres.

Total length excluding caudal	43·0
Length of head . .	11·0
Height of head at occiput	8·0
Width of head .	6·0
Length of snout	3·0
Diameter of eye .	3·3
Interorbital width	4·1
Height of body .	11·0
Width of body .	5·0
Longest ray of dorsal	8·3
Longest ray of anal	7·5
Length of pectoral	9·0
Length of caudal peduncle	9·0
Least height of caudal peduncle	6·0

Burbus (Puntius) binduchitra,[3] sp. nov.

D.3/8; A.3/5; P.16; V. 10; C.19; L.1.28-30; L.tr.$5\frac{1}{2}/4\frac{1}{2}$.

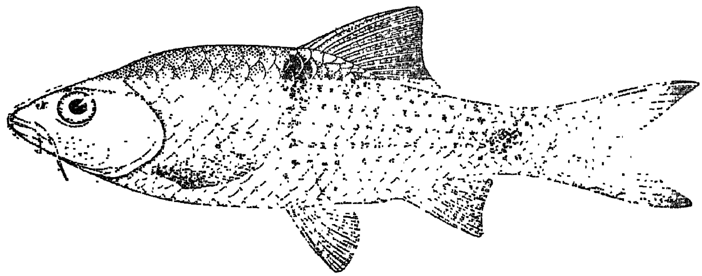
Puntius binduchitra is a small species in which both the dorsal and the ventral profiles are considerably arched. The body is greatly compressed; the dorsal surface in front of the dorsal fin is more or less keeled. The head is bluntly pointed; its length is contained from 4·5 to 4·7 times in the total length, and from 3·4 to 3·7 times in the length without the caudal. The height of the head at the occiput is contained from 1·1 to 1·2 times and its width from 1·3 to 1·6 times in its length. The head is proportionately smaller in the young specimens. The eye is lateral and situated close to the dorsal surface of the head; its diameter is almost equal to the length of the snout and is contained from 2·6 (in the young) to 3·5 times in the length of the head; usually it is contained from 3 to 3·5 times in the length of the head. The interorbital space

[1] Weber & de Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 85 (1916).
[2] Hora & Mukerji, *Rec. Ind. Mus.*, XXXVI, p. 130 (1934).
[3] *Binduchitra* is a combined Sanskrit word which means "spotted". In the specific name reference is made to the characteristic colouration of the species.

is flat and in the young specimens it is equal to the diameter of the eye; in older specimens it is somewhat greater than the diameter of the eye. The nostrils are situated close to the front border of the eye and are separated by a flap of skin. The mouth is semicircular, almost inferior and sub-terminal. The lips are thin but continuous; the labial groove is interrupted in the middle. There are two pairs of well developed barbels; the rostral barbels are equal to the diameter of the eye, but the maxillary barbels are somewhat longer.

The depth of the body increases with growth; it is contained from 3·6 to 4·4 times in the total length and from 2·8 to 3·4 times in the length without the caudal. The least height of the caudal peduncle is contained from 1·1 to 1·4 times in its length. The scales are large and firmly adherent; there are from 28 to 30 series of scales along the lateral line, 5½ rows above it and 3½ rows below it to the base of the pelvic fin. The number of predorsal scales varies from 9 to 10. There are 14 scales round the caudal peduncle. The pelvic fin is provided with a scaly appendage at its base. The rows of scales at the bases of the dorsal and anal fin contain somewhat smaller scales and their shape is also different from those covering the other parts of the body.

The dorsal fin commences slightly in advance of the pelvics and somewhat nearer to the base of the caudal fin than to the tip of the snout; its longest ray is usually shorter than the head. The last simple ray is articulated, but is serrated along the inner border. The anal fin is provided with 3 spines and 5 branched rays, the last of which is divided to the base. The pectoral fin is considerably shorter than the head and does not extend to the pelvic fin. The vent is situated just in front of the anal fin. The caudal fin is deeply forked; both the lobes are pointed; it is invariably longer than the head.



TEXT-FIG. 4.—Lateral view of the type-specimen of *Barbus* (*Puntius*) *binduchitra*, sp. nov. ×1¼.

The most characteristic feature of the species is its colouration. In all specimens there is a broad vertical band below the commencement of the dorsal fin which extends to the lateral line and a black blotch on the sides of the tail slightly in front of the base of the dorsal fin. In specimens over 56 mm. in total length, the scales above the lateral line and posterior to the large mark develop small rounded black spots in the centre so that the body in this region becomes spotted in a series of rows. Similar black spots appear on the scales of the lateral line and of those of the two rows below it, but they extend anteriorly beyond

the limit of the vertical mark. The upper edge of the dorsal and both the upper and lower margins of the caudal, especially the lower, become dusky in half-grown specimens and intensely black in somewhat older specimens.

Type-specimen.—F. 12478/1, Zoological Survey of India, Indian Museum, Calcutta.

Habitat.—Road-side drains and small streams at Sandoway, Lower Burma.

Remarks.—In its spotted colouration as well as in the possession of 4 well developed barbels and a serrated dorsal spine, *B. binduchitra* shows considerable affinity to *B. pinnauratus* (Day[1]) from South India and *B. sewelli* Prashad and Mukerji[2] from the Myitkyina District. In *B. sewelli* the body is considerably deeper (2·3 to 2·5 times in the length with the caudal in specimens over 90 mm. in length without the caudal), and there is always a large black blotch behind the gill-opening. Moreover, the vertical band and the caudal spot characteristic of the new species are lacking in *B. sewelli*. Both the species agree in having the dorsal surface in front of the dorsal fin keeled. *B. binduchitra* has greater affinity with *B. pinnauratus*, but its head is proportionately longer and not so high, the eye is relatively smaller, the interorbital width is less, the body is not so high but is relatively more compressed. Most of these differences seem to be correlated with the keeled nature of the dorsal surface in the new species ; in *B. pinnauratus* the dorsal surface is flatly rounded. In *B. pinnauratus* there is a black band behind the gill-opening and in some specimens a short oval spot below the commencement of the dorsal fin[3]; it has hitherto been known " From fresh waters at Coconada down the east coast of India to Ceylon, and inland as far as the Neilgherries, also along the Western Ghats and rivers at their bases,"[4] but recently Mr. Duncan sent me very similar specimens from the Chindwin drainage near the border of Assam and Burma. Comments on his specimens are made below on p. 336.

Measurements in millimetres.

Total length including caudal . . .	78·0	72·0	69·0	56·0	56·0	50·0	49·0	46·0	43·0	39·0	38·0
Length of caudal . .	18·5	15·3	16·0	12·5	12·3	12·0	11·5	11·0	10·3	9·0	9·0
Depth of body . .	20·2	20·0	18·8	15·0	15·0	13·0	12·3	10·5	10·0	9·0	8·5
Length of head . .	16·5	16·0	14·0	12·0	12·0	11·0	11·0	10·0	9·5	8·0	8·0
Height of head at occiput	13·3	13·0	12·5	11·0	11·0	9·0	9·0	8·0	7·5	7·0	7·0
Width of head . .	11·5	10·0	9·9	7·5	7·5	7·5	8·0	7·0	6·5	5·5	5·0
Length of snout . .	5·3	4·8	4·0	3·6	3·9	3·5	3·5	3·0	3·0	3·0	3·0
Diameter of eye . .	5·1	4·8	4·0	3·6	3·9	3·5	3·5	3·0	3·0	3·0	3·0
Interorbital width . .	5·7	5·0	4·8	4·3	4·5	4·0	4·0	3·5	3·3	3·0	3·0
Longest ray of dorsal .	14·5	14·0	14·0	10·3	10·3	10·0	10·0	9·0	9·0	8·0	8·0
Longest ray of anal .	10·0	10·0	10·0	7·5	8·0	7·0	7·0	6·5	6·3	5·0	5·0
Length of pectoral . .	12·0	12·0	11·3	8·5	9·0	7·3	7·3	6·8	6·5	6·0	6·0
Length of caudal peduncle	11·0	9·0	8·5	7·0	8·0	7·0	7·0	6·0	5·5	5·0	5·0
Least height of caudal peduncle . . .	8·2	8·0	8·0	6·5	6·5	6·0	5·0	5·0	4·5	4·0	4·0

[1] Day, *Proc. Zool. Soc. London*, p. 300 (1865).
[2] Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 197, pl. ix, fig. 1 (1929).
[3] Hora, *Rec. Ind. Mus.*, XXXIX, p. 9, fig. 1 (1937).
[4] Day, *Fish. India*, p. 562 (1877).

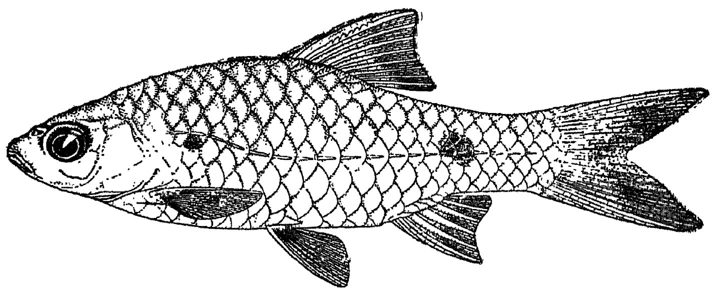
Barbus (Puntius) stoliczkanus Day.

1869. *Barbus M'clellandi*, Day (*nec* Cuvier & Valenciennes), *Proc. Zool. Soc. London*, p. 619.
1871. *Barbus* (*Puntius*) *Stoliczkanus*, Day, *Journ As. Soc. Bengal*, XL, pt. 2, p. 328.
1877. *Barbus stoliczkanus*, Day, *Fish. India*, p. 577, pl. cxliv, fig. 8.
1889. *Barbus stoliczkanus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 326.
1893. *Barbus stoliczkanus*, Boulenger, *Ann. Mag. Nat. Hist.*, (6), XII, p. 202.
1918. *Barbus stoliczkanus*, Annandale, *Rec. Ind. Mus.*, XIV, p. 35.
1919. *Barbus stoliczkanus*, Chaudhuri, *Rec. Ind. Mus.*, XVI, p. 283.

Barbus stoliczkanus was originally described from a series of 21 specimens, 6 from Pegu and 15 from Moulmein, up to 4 inches in length. It was observed by Day that :—

"This species bears a strong resemblance to the *B. ticto*, H. B., which it appears to supersede in Eastern Burma. But it is distinguished by a complete instead of incomplete lateral line, and its body is not so compressed ; its dorsal spine and colouring also differ."

The dorsal spine of this species is less strongly serrated than in *B. ticto*, while the position of the lateral spots is also different. The most important difference between the two species, however, lies in the number of the predorsal scales—8 to 9 in *B. stoliczkanus* and 11 in *B. ticto*. The



TEXT-FIG. 5.—Lateral view of a specimen of *Barbus* (*Puntius*) *stoliczkanus* Day.

extent of the lateral line in the 5 specimens from Sandoway is variable ; in two specimens it is almost complete, in two other specimens it extends over 17 to 19 scales while in one specimen it is limited to the first 7 scales. Sometimes the extent of the lateral line varies on the two sides of the same fish.

Day (1877) noted that "Some Darjeeling examples agree with the Burmese fish." Since Day's time, however, the species has been recorded only from Northern Burma (Boulenger : S. S. States ; Chaudhuri : Putao). The Sandoway specimens are young, none exceeding 47 mm. in total length ; they were collected from a road-side drain. In their proportions, lepidosis and number of fin rays, they agree with Day's description of the species, except in having a somewhat different colouration.

Measurements in millimetres.

Total length including caudal	47·0	42·0	41·0	40·0	37·0
Length of caudal	11·0	9·0	10·0	9·0	9·0
Length of head	8·0	7·0	7·0	7·0	7·0
Height of body	14·5	13·5	12·2	11·0	10·5
Diameter of eye	3·0	2·5	2·5	2·5	2·5
Length of snout	2·5	2·0	2·0	2·0	2·0
Interorbital distance	4·0	3·8	3·8	3·5	3·5
Commencement of dorsal from tip of snout .	18·5	17·0	16·0	15·0	15·0
Longest ray of dorsal	9·5	8·0	8·0	8·0	8·0

Panchax panchax (Ham.).

1889. *Haplochilus panchax*, Day, *Faun. Brit. Ind. Fish.*, I, p. 417.

There are two specimens, about 44 mm. in total length, of *Panchax panchax* in the collection from Sandoway; they were collected from a road-side drain. *P. panchax* is a widely distributed species of the Oriental Region; its range extends from Orissa, through Lower Bengal, to Burma, Andaman Islands, Siam, Malay Peninsula and the Archipelago.

XXXII.—ON A SMALL COLLECTION OF FISH FROM THE UPPER CHINDWIN DRAINAGE.

At my request Mr. S. J. Duncan, Sub-Divisional Officer at Ukhrul, Manipur State, Assam, in the course of his tours made a small collection of fish for the Zoological Survey of India from the Upper Chindwin Drainage. As the area traversed by him is very close to the boundary between Assam and Burma, the material is of special interest for zoogeographical studies, and throws considerable light on the distribution of some of the species represented in the collection.

The material consists of 46 specimens which are referable to 12 species belonging to the families Cyprinidae, Cobitidae, Sisoridae and Ophicephalidae. These are listed below according to the localities from where the material was obtained.

1. Small stream below the village Singcha Tangkhul flowing into the Khunukong or Namballok (called Nampanga in Burma). 21.1.1937.

i. *Oreinus molesworthi* Chaudhuri. . . . . 2 specimens.

2. Small stream below the village Chahong Khulen flowing into the Khunukong or Namballok. 25.1.1937.

i. *Barbus hexagonolepis* McClelland . . . . 1 specimen.
ii. *Barbus clavatus* McClelland . . . . . 1 specimen.

3. Upper reaches of the Namya river at Kongan Thana, a Kabo or Shan village. 28.1.1937.

i. *Barilius barila* Ham. . . . . . . 1 specimen.
ii. *Labeo devderi* Hora . . . . . . 4 specimens.
iii. *Garra gotyla* (Gray). . . . . . . 4 specimens.
iv. *Barbus myitkyinae* Prashad & Mukerji . . 2 specimens.
v. *Nemachilus vinciguerrai* Hora . . . . . 7 specimens.
vi. *Glyptothorax trilineatus* Blyth . . . . . 3 specimens.
. . . . . 2 specimens.

4. Chakpi river at Chakpi Karong. 1.iii.1937.

i. *Barilius barila* Ham. . . . . . . 3 specimens.
ii. *Barbus pinnauratus* (Day) . . . . . 3 specimens.
iii. *Barbus clavatus* var. *burtoni* Mukerji . . 2 specimens.

5. Lokchao river at Tamu. 15.iii.1937.

i. *Barbus pinnauratus* (Day) . . . . . 5 specimens.
ii. *Lepidocephalichthys berdmorei* (Blyth) . . 6 specimens.

The range of distribution of the following species is extended in this article : *Barbus myitkyinae, B. pinnauratus* and *Glyptothorax trilineatus*. The most interesting record is that of *B. pinnauratus* which was hitherto known from South India only. It is also clear from the collection that the typical Burmese fauna is well represented in the Upper Chindwin Drainage.

I take this opportunity to record my sincere thanks to Mr. S. J. Duncan for the opportunity he has afforded me of examining fishes from a zoologically interesting region. The material is in an excellent state of preservation and forms a valuable addition to the collection of the Zoological Survey of India. Mr. Duncan's notes on the colouration of the species, reproduced below, are most helpful.

Family CYPRINIDAE.

Barilius barila Hamilton.

1921. *Barilius barila*, Hora, *Rec. Ind. Mus.*, XXII, p. 190.

Vernacular Names.—Thēlbōl Kuki ; *Ngapāilā* Tangkhul ; *Pakham* Kabo.

1 specimen. Namya river at Kongan Thana. 28.i.1937.
3 specimens. Chakpi river at Chakpi Karong. 1.iii.1937.

There are altogether 4 specimens of *Barilius barila* in the collection, ranging in length from 105 mm. to 120 mm. in total length. In none of the specimens the outer rays of the pectoral fins are specially strengthened for the purpose of adhesion to rocks. In all the specimens, particularly those from the Chakpi river, the body is covered with a number of black spots which represent encysted Trematode larvae ; these should not to be confused with the colour markings. According to Mr. Duncan's observations the colouration is as follows :—

"Dorsal surface dark. Ventral white (or silvery). The sides are transversed by dark bluish broad stripes running parallel to each other. Fins pinkish."

B. barila is known both from India and Burma.

Oreinus molesworthi Chaudhuri.

1913. *Oreinus molesworthi*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 247, pl. vii, figs. 2, 2*a*, 2*b*.

1935. *Oreinus molesworthi*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVII, p. 391.

Vernacular Names.—Sana-nga Manipuri ; *Nganam* Kuki ; *Khaingui* Tangkhul. The Manipuri name means " Goldfish".

2 specimens. Stream below Singcha Tangkhul. 21.i.1937.

Oreinus molesworthi is represented by 2 young specimens in the collection which are about 130 mm. and 142 mm. in total length

respectively. Though the specimens were collected only from one small stream below Singcha Tangkhul, Mr. Duncan states that "This fish is also found in other streams of the same drainage, but it is *not* found in all streams. It inhabits mostly the higher and colder reaches of the streams where they are found." It may be noted here that the type-specimen, 202 mm. in total length, was collected from Yembung at an altitude of 1,100 feet only.

Mukerji and I had recently extended the range of the species to the Chindwin drainage system in the Naga Hills.

According to Mr. Duncan the colouration of the species is as follows :—

"The dorsal surface is dark brown. This colour decreases in intensity as it approaches the dark thin line that runs right through the middle of the side from the angle of the operculum to the root of the caudal fin. When looked at laterally the colour appears steel grey. Below the dark line the colour is silvery white. The ventral surface is also white. The scales are very very small. Fins are slightly pinkish except perhaps the dorsal."

Labeo devdevi Hora.

1934. *Labeo (Labeo) dyocheilus* (in part), Mukerji (*nec* McClelland), *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 55-59 (Burmese and Siamese form, p. 58).

1936. *Labeo devdevi*, Hora, *Rec. Ind. Mus.*, XXXVIII, pp. 323-324.

Vernacular Names.—*Ngatin Macha* Manipuri ; *Ngachuntam* Kuki ; *Ngalu* Kabo.

4 specimens. Namya river at Kongan Thana. 28.i.1937.

In Mr. Duncan's collection *Labeo devdevi* is represented by 4 young specimens, varying in length from 83 mm. to 92 mm. in total length. Its superficial resemblance to *L. dero* (Ham.) is very great indeed ; but the two species can be readily distinguished by their lepidosis. Both *L. dero* and *L. devdevi* are liable to be confused with *L. dyocheilus* McClelland, but I have shown in the paper referred to above that McClelland's species has a very characteristic type of adhesive surface of the lower lip.

According to Mr. Duncan the colouration of the species is as follows :—

"Dark green dorsal surface and white ventral. The scales are small and have a coppery tint. Opercular region with a golden tint. Fins pinkish."

Garra gotyla (Gray).

1921. *Garra gotyla*, Hora, *Rec. Ind. Mus.*, XXII, p. 653.

1936. *Garra gotyla*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, p. 144.

Vernacular Names.—*Ngamu Sangkhom* Manipuri ; *Ngapum* Kuki ; *Masanglu* Tangkhul ; *Pachup-hen* Kabo.

4 specimens. Namya river at Kongan Thana. 28.i.1937.

Garra gotyla is perhaps the most widely distributed species of the genus, as it is found all along the Himalayas. The four specimens in Mr. Duncan's collection are from 97 mm. to 104 mm. in total length. The colour is almost black along the dorsal surface and the sides. Mr. Duncan found that "The whole body of the fish is dark green in colour except the ventral surface which is flattish and white." All the specimens are provided with a well developed proboscis on the snout.

In 1921, I[1] recorded *G. gotyla*, for the first time, from the north-eastern border of Burma and the Naga Hills.

Barbus hexagonolepis McClelland.

1936. *Barbus hexagonolepis*, Hora, *Rec. Ind. Mus.*, XXXVIII, p. 330.

Vernacular Names.—*Ngara* Manipuri; *Ngaha* Kuki.

1 specimen. Stream below Chahong Khulen. 25.i.1937.

In the paper referred to above I discussed the specific limits of the various species of the large-scaled Barbels found in Assam. It was also indicated that *B. hexagonolepis* is the commonest Barbel of the torrential streams of the Naga Hills. In Mr. Duncan's collection there is only one specimen, about 107 mm. in length without the caudal. Mr. Duncan states that it is the mighty *Mahseer* of this region and observes that it " is found in almost all the rivers in these hills ". His description of the colour is as follows :—

" Dark green dorsal surface. A white (sometimes yellowish) broad line runs laterally and below it another dark broad line runs in the same direction from the operculum to the root of the caudal fin. White ventral surface."

Barbus myitkyinae Prashad and Mukerji.

1929. *Barbus myitkyinae*, Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 198, pl. ix, figs. 2, 2*a*, 2*b*.

Vernacular Names.—*Ngasang* Kuki; *Khaisang* Tangkhul; *Pachak* Kabo.

2 specimens. Namya river at Kongan Thana. 28.i.1937.

In Mr. Duncan's collection there are two specimens of *Barbus myitkyinae*, 97 mm. and 104 mm. in total length respectively. The species was described from the Myitkina District, Upper Burma, where it is stated to be quite common in the Indawgyi Lake and the streams in the adjacent area. The present record of *B. myitkyinae* from the Upper Chindwin Drainage shows that the species is probably widely distributed in the headwaters of the Chindwin and the Irrawadi rivers.

Barbus clavatus McClelland.

1921. *Barbus clavatus*, Hora, *Rec. Ind. Mus.*, XXII, p. 185, pl. ix, fig. 1.
1935. *Barbus clavatus*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVII, p. 388.

Vernacular Names.—*Ngasang* Kuki; *Khaisang* Tangkhul.

1 specimen. Stream below Chahong Khulen. 25.i.1937.

From the vernacular names and the notes supplied by Mr. Duncan it seems that the local people make no distinction between *Barbus clavatus* and *B. myitkyinae*. The two species are, however, abundantly distinct and can be readily distinguished by the relative length of the dorsal spine, which in the former is considerably longer than the head. The dorsal surface of *B. clavatus* in front of the dorsal fin is distinctly keeled.

Mr. Duncan notes that this fish is called, rightly or wrongly, the " White Mahseer ". ' Mahseer ' can only be used for this species in a

[1] Hora, *Rec. Ind. Mus.*, XXII, p. 743 (1921).

very loose sense, as it neither possesses large scales nor is its dorsal spine smooth. Moreover, the body of *B. clavatus* is considerably more compressed than that of the ' Mahseers '.

According to Mr. Duncan, the colouration of the species is as follows :—

" Dorsal surface dark green. Ventral surface white. The head or rather the opercular region golden tint. The whole body shows a slight golden tint when held up against the sun."

The only specimen of the species in Mr. Duncan's collection is about 112 mm. in total length.

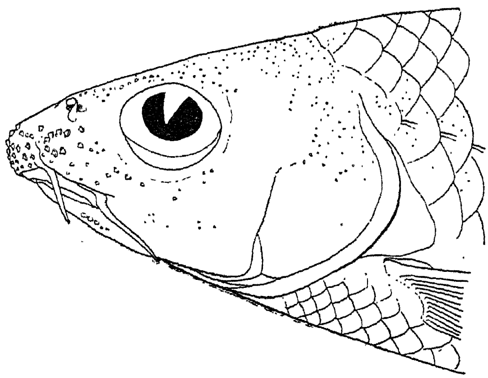
Barbus clavatus burtoni Mukerji.

1934. *Barbus clavatus burtoni*, Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 64, pl. iii, fig. 1 and text-figures 10 & 11.

Vernacular Name.—*Ngasang* Kuki.

2 specimens. Chakpi river at Chakpi Karong. 1.iii.1937.

In describing *burtoni* as a subspecies of *Barbus clavatus*, Mukerji distinguished it from the typical form by its longer snout (greater than the diameter of the eye), shorter dorsal spine (less than the length of the head), lepidosis (small number of scales) and colouration (much darker, especially along the dorsal surface). In all these characters the two specimens in Mr. Duncan's collection, 132 mm. and 142 mm. in total length respectively, agree with the subspecies *burtoni*. The dorsal half



Text-fig. 6.—Lateral view of head and anterior part of body of *Barbus clavatus* var. *burtoni* Mukerji, showing tubercular areas on the snout. ×2.

of the fish is intensely dark ; the whole of the caudal fin is dusky and especially the lower lobe. The membranes in between the dorsal rays are black, except at the bases. The distal portion of the anal fin is grayish as also the dorsal surface of the pectoral fins. As in the typical form, the dorsal surface in front of the dorsal fin is distinctly keeled. In both the specimens the snout is provided with rows of well defined tubercles.

Although Kuki Nagas make no distinction between the typical form and the subspecies *burtoni*, Mr. Duncan distinguished them in the field by their different colouration.

Barbus pinnauratus (Day).

1877. *Barbus pinnauratus*, Day, *Fish. India*, p. 561, pl. cxxxix, fig. 3.
1937. *Barbus pinnauratus*, Hora, *Rec. Ind. Mus.*, XXXIX, p. 9, fig. 1.

Local Name.—*Ngahao* Manipuri.

3 specimens. Chakpi river at Chakpi Karong. 1.iii.1937.
5 specimens. Lokchao river at Tamu. 15.iii.1937.

According to Day, *Barbus pinnauratus* is found in "fresh waters at Coconada down the East coast of India to Ceylon, and inland as far as the Neilgherries, also along the Western Ghats and rivers at their bases". So far as I am aware[1] this species has not been found so far in any other part of India, and its present record from the Upper Chindwin is, therefore, of exceptional interest. Attention may here be directed to the similar distribution of *Danio strigillifer* Myers[2] which was originally described from Upper Burma but was recently recorded from South India.[3] To explain these and several other similar cases of a discontinuous range of distribution I[4] recently advanced a hypothesis. According to this view, when through a differential orogenic movement in the region of the present high peaks of the Himalayas (the region between the Assam and the Nepal Himalayas), the Himalayas were uplifted the migration of the aquatic fauna towards the Western Himalayas was checked and diverted along the Satpura trend of mountains to the Western Ghats whence it spread southward to the hills of the Peninsula. There is abundant evidence in favour of such a view both from the distribution of fishes and from the palaeogeographical features of the country during the Tertiaries.

The specimens in Mr. Duncan's collection agree very closely with those from South India, except that the spots on the scales are not so well defined and the head is relatively smaller. The younger specimens possess a black mark below the dorsal spine similar to the one recently described by me in the Tunga river specimens.

Sundara Raj[5] referred to the close similarity between *B. chrysopoma*, *B. pinnauratus* and *B. sarana*, all occurring in the Madras Presidency. To this complex of allied species may be added *B. caudimarginatus*, *B. oatesii*, *B. sewelli*, *B. mitkyinae*, *B. binduchitra* (a new species described above *vide* p. 327), etc., from Burma. In discussing the relationships of the new species I have already referred to the distinguishing features of *B. sewelli* and *B. pinnauratus*.

To bring out the close similarity in proportions, etc., between the South Indian and the Upper Chindwin specimens of *B. pinnauratus*

[1] Karoli (*Term. füzetek*, V, p. 179, 1882) recorded *Barbus pinnauratus* by name only from Siam and Java. Weber and de Beaufort did not include this species in their work on the "Fishes of the Indo-Australian Archipelago". Suvatti has, however, listed *B. pinnauratus* in his "Index to Fishes of Siam" on the authority of Karoli. Without further details it is not possible to be sure of Karoli's record.

[2] Myers, *Amer. Mus. Novitates*, No. 150, p. 1 (1924).

[3] Hora, *Rec. Ind. Mus.*, XXXIX, p. 10, fig. 3 (1937).

[4] Hora, *Rec. Ind. Mus.*, XXXIX, p. 255 (1937).

[5] Sundara Raj, *Rec. Ind. Mus.*, XII, p. 254 (1916); also see Annandale, *Rec. Ind. Mus.*, XIV, p. 46 (1918).

I give below a table of measurements of the specimens from the two regions.

Measurements in millimetres.

	Upper Chindwin.				Shimoga.	
Total length	83·0	90·0	103·0	116·0	83·0	92·0
Length of caudal	18·0	20·0	23·0	25·0	18·0	20·0
Length of head	15·0	16·0	17·2	21·5	16·0	19·0
Height of head	14·0	15·0	16·0	20·0	14·5	17·0
Width of head	11·0	12·2	13·0	16·1	12·0	13·0
Length of snout	4·0	5·0	5·0	6·0	5·0	5·0
Diameter of eye	6·0	6·5	6·5	7·0	6·1	6·8
Interorbital width	7·0	7·5	8·2	10·0	6·9	7·0
Height of body	23·0	26·0	27·0	32·0	24·0	25·0
Width of body	12·0	13·5	14·0	16·5	13·0	12·0
Longest ray of dorsal fin	14·0	17·0	21·0	23·0	15·0	18·0
Longest ray of anal fin	11·0	12·0	13·0	14·0	11·0	12·0
Length of pectoral fin	12·3	14·5	16·0	19·0	13·0	14·0
Length of caudal peduncle	12·0	13·0	13·5	16·0	12·0	13·0
Least height of caudal peduncle	9·0	10·0	11·0	13·0	9·0	10·0

Mr. Duncan made the following observations about the colouration of the species :—

"Dark dorsal and white ventral surface. In young specimens a biggish black spot, though not very prominent, on the body near the beginning of the caudal fin."

Family COBITIDAE.

Nemachilus vinciguerrai Hora.

1935. *Nemachilus vinciguerrae,* Hora, *Rec. Ind. Mus.,* XXXVII, p. 62, pl. iii, fig. 12.

Vernacular Names.—Ngajou Kuki; *Hangkorkhai* Tangkhul; *Pasulai* Kabo.

7 specimens. Namya river at Kongan Thana. 28.i.1937.

In Mr. Duncan's collection there are seven specimens of *Nemachilus vinciguerrai* ranging from 57 mm. to 76 mm. in total length. They agree fairly closely with the species recently described by me from Burma and Siam. Mr. Duncan's description of the colouration is as follows :—

"The general effect of the colouration scheme is a dirty biscuit colour, but the whole body is marked with transverse zebra stripes of light and dark alternately. The stripes are narrow in front of the dorsal and broader behind it as they approach towards the caudal fin. Fins have red edges."

In larger specimens the broader stripes behind the dorsal fin are stated to be alternately pink and dark.

Lepidocephalichthys berdmorei (Blyth).

1921. *Lepidocephalichthys berdmorei,* Hora, *Rec. Ind. Mus.,* XXII, p. 196.

Local Names.—Nga Krichou or *Nga Kachirou* Manipuri.

6 specimens. Lokchao river at Tamu. 15.iii.1937.

The specimens of *Lepidocephalichthys berdmorei* in Mr. Duncan's collection range from 46 mm. to 75 mm. in total length. In the smaller individuals the caudal fin is more markedly emarginate. Usually there

is a dark spot in the upper portion of the caudal fin near the base, but in the largest individual there is a well marked black ocellus in the same situation. This species is widely distributed in the Burmese waters.

Family SISORIDAE.

Glyptothorax trilineatus Blyth.

1923. *Glyptothorax trilineatus*, Hora, *Rec. Ind. Mus.*, XXV, p. 29.

Vernacular Names.—Monglheng Kuki; *Ngaprangla* Tangkhul; *Payahat* Kabo.

3 specimens. Namya river at Kongan Thana. 28.i.1937.

Glyptothorax trilineatus is represented by 3 specimens varying from 78 mm. to 87 mm. in total length. They possess the characteristic three white streaks and agree in every respect with Blyth's description of the species. Mr. Duncan observes that it is not a very common fish. The largest specimen he had ever caught was about 5 to 6 inches in length. The colouration of the living specimens is noted by him as follows :—

"Dark brown colour with a reddish tint. A light line runs laterally on both sides as well as along the dorsal profile. Fins very light red."

G. trilineatus is known from Tenasserim, Rangoon and Upper Burma. It is here recorded from the Chindwin Drainage for the first time.

Family OPHICEPHALIDAE.

Ophicephalus gachua Ham.

1935. *Ophicephalus gachua*, Hora & Mukerji, *Rec. Ind. Mus.*, p. 404.

Vernacular Names.—Ngamu Manipuri; *Ngavoh* Kuki; *Khaivā* Tangkhul.

2 specimens. Namya river at Kongan Thana. 28.i.1937.

In Mr. Duncan's collection there are two young specimens of *Ophicephalus gachua*; they are about 85 mm. in total length. The colouration of the species, according to Mr. Duncan's notes, is as follows :—

"Dark colour. White and greenish ventral. The body shows angular bands. The fins have half circles of light and dark."

XXXIII.—On a collection of Fish from the Kumaon Himalayas.

In May-June 1936, Mr. E. O. Shebbeare, Chief Conservator of Forests, and Mr. M. P. Bhola, Divisional Forest Officer, Haldwani Division, made a small collection of fish for me in the outer Himalayan hills below Naini Tal. The fish were obtained from the Nandhaur and Kalaunia rivers; the former has its source in the Naini Tal District and flows over a bed of boulders. Within the hills its valley is narrow but broadens out in the plains. The fish were collected in the rocky portion of the stream. The Kalaunia river is similar to that of the Nandhaur river in its general physical features, but its source lies in the outer Himalayan hills of the Almora District. The fauna of the two streams is almost identical.

The entire collection comprises 207 specimens which belong to the following species.

MASTACEMBELIDAE.

Mastacembelus armatus (Lacép.) . . .	1 specimen.

CYPRINIDAE.

Barilius bendelisis Ham.	24 specimens.
Barilius vagra Ham.	9 specimens.
Brachydanio rerio (Ham.)	7 specimens.
Labeo dero (Ham.)	9 specimens.
Garra gotyla (Gray)	8 specimens.
Garra prashadi Hora.	77 specimens.
Crossochilus latius (Ham.)	4 specimens.
Barbus putitora (Ham.)	17 specimens.
Barbus chilinoides McClelland	2 specimens.
Barbus conchonius (Ham.)	2 specimens.

COBITIDAE.

Nemachilus botia (Ham.)	13 specimens.
Nemachilus beavani Günther	22 specimens.
Lepidocephalichthys guntea (Ham.) . . .	3 specimens.

SISORIDAE.

Glyptothorax pectinopterus (McClelland) . .	2 specimens.

ABLYCEPIDAE.

Amblyceps mangois (Ham.)	1 specimen.

OPHICEPHALIDAE.

Ophicephalus gachua Ham.	6 specimens.

The majority of the species listed above represent well known forms. Attention may, however, be directed to *Garra prashadi*, which was hitherto known from 3 specimens obtained in Malwa Tal; and to *Nemachilus beavani*, the precise specific limits of which were only recently defined by me from examples collected in the Eastern Himalayas. Notes on these two species are given below.

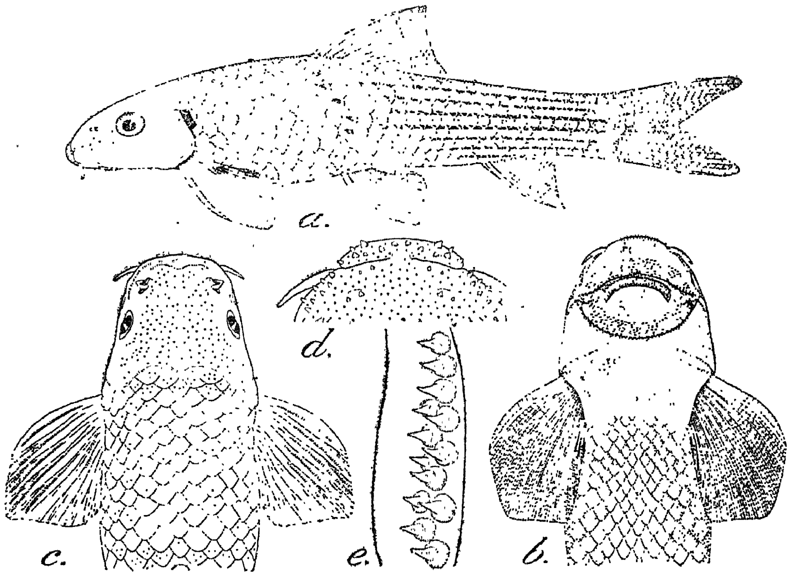
I take this opportunity to offer my sincere thanks to Messrs. E. O. Shebbeare and M. P. Bhola for their kindness in making a valuable collection of fish for the Zoological Survey of India.

Garra prashadi Hora.

1921. *Garra prashadi*, Hora, *Rec. Ind. Mus.*, XXII, p. 669, pl. xxiv, fig. 3.

As indicated above *Garra prashadi* was described from 3 specimens, of which 2 were males and 1 damaged female. Now a large series of 77 specimens has become available and it is possible to make some observations on the sexual dimorphism exhibited by the fish. In species of *Garra*, in which a well-developed proboscis is present on the snout, usually both the sexes are provided with 'pearl organs', etc.

In this respect I noted some sexual differences in the case of *G. lamta* and *G. gravelyi.* As regards the former species further material has shown (*vide infra*, p. 344) that I had grouped two distinct forms under *lamta.* The material of the latter species is not sufficient to elucidate this point.



TEXT-FIG. 7.—*Garra prashadi* Hora.

a. Lateral view of a female specimen. Nat. size; *b.* Ventral surface of head and anterior part of body of above. ×1½; *c.* Dorsal surface of head and anterior part of body of a male specimen. ×1½; *d.* Dorsal surface of snout of a female specimen. ×3½; *e.* Dorsal surface of a portion of one of the outer pectoral fin-rays of a male specimen showing the nature of horny tubercles. ×35.

In the female specimens of *G. prashadi* the tip of the snout is marked off by a shallow transverse groove and is covered with a few horny tubercles. A few horny tubercles are also present on the sides of the head in front of the eyes. In the males, however, the snout is smooth and there are only faint indications of two short lateral grooves which mark off the tip of the snout. The dorsal surface of the head in front of the eyes is slightly raised into two triangular patches; these areas are better marked in the female specimens. In the males the outer rays of the pectoral fins are provided with series of spines on the dorsal surface similar to those described by me[1] in the males of certain species of *Nemachilus.* As is usually the case, the body is relatively deeper in the females as compared with the males.

From the table of measurements given below, it will be seen that the head is relatively longer and the eye larger in young specimens. Other proportions also vary with growth to a limited extent.

[1] Hora, *Rec. Ind. Mus.*, XXIV, p. 81 (1922).

Measurements in millimetres.

Total length including caudal . .	75·0	82·0	96·0	61·0	75·0	82·0
Length of caudal	16·0	17·1	21·0	14·0	16·0	17·1
Length of head	14·5	15·1	17·0	12·0	14·3	15·0
Width of head	12·0	12·5	14·1	10·0	11·3	12·0
Height of head at occiput . . .	10·0	10·5	12·1	8·0	10·0	10·5
Height of body	16·0	16·5	21·0	11·0	15·0	15·5
Width of body	11·3	13·0	16·0	9·0	11·0	12·0
Length of snout	7·0	7·1	8·0	6·0	7·0	7·1
Diameter of eye	4·0	4·0	4·7	3·8	4·0	4·0
Interorbital width	7·0	7·0	8·0	6·0	7·0	7·1
Length of caudal peduncle . . .	10·1	11·0	14·0	8·0	10·0	11·0
Least height of caudal peduncle . .	8·0	8·8	11·0	6·2	8·0	8·8
Longest ray of dorsal	15·0	15·0	18·5	12·0	15·2	15·3
Length of pectoral	14·0	15·0	18·0	12·1	15·0	16·0
Longest ray of anal	12·8	12·5	15·0	9·5	12·0	13·0

In *G. prashadi* the skin covering the anterior fin rays of the dorsal, the pectoral, the ventral, and the anal fins is produced into lappets which form a sort of a sheath for the following ray or rays. Such structures are characteristic of practically all torrential fishes and attention has already been directed to this feature by Smith and Deraniyagala. Their exact significance appears to be to provide a gliding surface for the current and thus minimise resistance. Their production seems to have been facilitated by the tearing away action of the current which would natu pull an object in the direction of its flow.

Nemachilus beavani Günther.

1924. *Nemachilus* sp., Hora, *Rec. Ind. Mus.*, XXVI, p. 28, fig. 1.
1935. *Nemachilus beavani*, Hora, *Rec. Ind. Mus.*, XXXVII, p. 63.

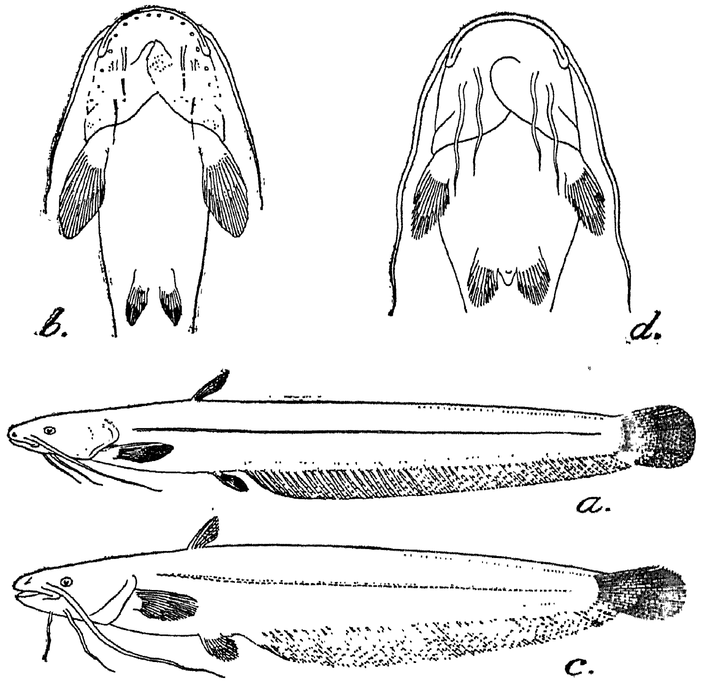
There are 22 examples in the collection under report which agree fairly closely with the Assamese and Eastern Himalayan specimens recently assigned by me to *Nemachilus beavani.* There are, however, variations in the number of bands and in the proportions of certain parts. It may here be noted that the species was originally described from the Kosi river and it is probable that the present lot represents the typical form of the species. I hope to deal with this point in my account of the species from the Western Himalayas.

XXXIV.—On a New Catfish from Kwangsi, China.

In his 'Study on some Chinese Catfishes', Tchang[1] referred a specimen of *Silurus* Linn. from Lunchow in the Kwangsi Province, China, to Day's *S. wynaadensis*, which is known only from the Wynaad and Canara Hills in South India. At the same time he published a full description of the specimen along with two illustrations—a lateral view

[1] Tchang, *Bull. Fan Mem. Inst. Biol.*, VII, p. 35 (1936).

of the whole fish and a view of the ventral surface of the body in front of the anal fin. As I[1] had been working recently on the Indian species of *Silurus*, this interesting record attracted my attention and I requested Mr. T. L. Tchang to lend me the specimen of his *S. wynaadensis* for comparison with the typical examples of the species in the collection of the Zoological Survey of India, but he regretted his inability to comply with my request. Fortunately his description and figures are sufficiently detailed to enable me to institute a comparison between his form and the typical examples.



TEXT-FIG. 8.—*Silurus wynaadensis* Day and *S. sinensis*, sp. nov.

a. Lateral view of *Silurus wynaadensis* Day. ×*ca* $\frac{4}{5}$; *b*. Ventral surface of head and anterior part of body of *S. wynaadensis* Day. ×$1\frac{1}{3}$; *c*. Lateral view of *S. sinensis*, sp. nov. *ca* $\frac{4}{5}$; *d*. Ventral surface of head and anterior part of body of *S. sinensis*, sp. nov. *ca* $1\frac{1}{3}$.

Figs. *c*. and *d*. are copied from Dr. T. L. Tchang's drawings.

In the Indian specimens the dorsal fin is entirely in advance of the ventrals, the pectorals are separated from the ventrals by a considerable distance and the maxillary barbels do not extend beyond the pectoral fin. In the specimen from Kwangsi a portion of the dorsal fin is situated above the bases of the ventrals, the pectorals almost extend to the bases of the ventrals and the maxillary barbels extend beyond the

[1] Hora, *Rec. Ind. Mus.*, XXXVIII, pp. 351-356 (1936).

commencement of the anal fin. A comparative table of proportions of the various parts is given below :—

	Kwangsi.	Wynaad.		Canara.
Length to base of caudal	90 mm.	100 mm.	122 mm.	123 mm.
Depth in length without caudal	6·0	9·1	8·1	7·3
Head in length without caudal	4·7	5·4	5·5	5·6
Eye in head	8·0	9·2	7·3	7·3
Interorbital distance in head	1·9	2·5	2·2	2·2
Snout in head	2·4	3·1	3·0	3·0
Outer Mandibular barbel in head	1·2	1·8	1·8	1·8
Inner Mandibular barbel in head	1·3	1·9	2·0	2·0
Longest dorsal ray in head	2·1	2·5	2·4	2·6
Pectoral in head	1·5	1·5	1·7	1·7
Ventral in head	2·5	3·0	3·1	3·1

It is clear from the above table that in the Chinese example the body is considerably deeper, the head is longer, the interorbital space wider, the snout longer and all the barbels much better developed than those in the Indian examples. On account of the differences noted above and also on geographical grounds it is necessary to regard Tchang's specimen of *S. wynaadensis* as representing a new species which I propose to name **Silurus sinensis.** For a description of the species reference may be made to Tchang's account. His illustrations are reproduced here along with fresh drawings of a typical specimen of *S. wynaadensis* for comparison.

The occurrence of a true *Silurus,* with 4 mandibular barbels, in South China is of special significance. Hitherto only two species of the genus, in its restricted sense, were known, *S. glanis* Linn. from Europe (east of the Rhine) and *S. wynaadensis* Day from South India. Among the species, which are usually included in the genus *Parasilurus* on account of having only two mandibular barbels, we have two very widely distributed species, one in the north, *Parasilurus asotus* (Linn.) known from Japan, China and Eastern Russia, and the other in the south, *P. cochinchinensis* (Cuv. & Val.), found in Formosa, South China, Cochin-China, Mergui Archipelago, Burma, and Eastern Himalayas. The remaining species of the group, *P. cinereus* (Dabry), *P. grahami* (Regan) and *P. mento* (Regan), are found only in Yunnan. It has been found that very young specimens of *Parasilurus asotus* are provided with 2 pairs of mandibular barbels[1] which shows that *Silurus* (s.s.) certainly represents a more primitive type of fish.

From the distributional records given above it is clear that the largest number of species of the genus *Silurus* are found in South China. In fact, all the species, with the exception of *S. glanis* and *S. wynaadensis,* have been found in this region. *S. glanis* and *S. wynaadensis* are characterised by 4 mandibular barbels and, therefore, represent the earliest stock of the genus which is now pushed out into very great distances from the original centre of the distribution of the genus. *Silurus sinensis* should, according to this view, represent a part of the original stock in the home country of the genus.

[1] Atoda, *Dolutsugaku rasshi,* XLVII, p 228 (1935); Kimura, *Journ. Shanghai Sci., Inst.* Sec. 3, III, p. 1(

XXXV.—A FURTHER NOTE ON HAMILTON'S *CYPRINUS (GARRA) LAMTA*.

In my[1] revision of the fishes of the genus *Garra* it was indicated that the type-locality of Hamilton's[2] *Cyprinus lamta* had to be located in " small streams among rocks south of Monghir " whence he obtained his specimens of *Godyari*, also called *Sahari*. It was further pointed out that in the ' rocks south of Monghir ' reference was probably made to the well-known Kharagpur Hills in the present-day district of Monghir. To elucidate the precise specific limits of the species, topotypes were obtained, but unfortunately I was only able to secure very young specimens, less than 50 mm. in total length. Among the material thus obtained two distinct types were recognised, one with a short central proboscis on the snout and the other without a proboscis. It was then presumed that the former represented the male and the latter the female of the same species. The characters of *G. lamta*, based on juvenile specimens, were, however, not found sufficiently distinctive by Prashad and Mukerji[3] and Mukerji[4], who referred certain examples from Burma to *Garra lamta*. It thus seemed clear that only mature specimens of *G. lamta* could enable a proper appreciation of the species.

In February 1937, I came to know that Mr. A. Das, a botanist and a keen naturalist, was touring in the Kharagpur Hills. A request was made to him to collect specimens of the local fish *Godyari* and sufficient details were sent for the recognition of the species. In March, I received 10 specimens of the desired type with a small miscellaneous lot. Mr. Das, like myself, found that *Garra* is known as *Patharchata*, stone-licking fish, in the Bhimband locality, Kharagpur Hills. The specimens, from 36 mm. to 67 mm. in length without the caudal, were collected from the Man river. The material contains the adult examples of both the sexes, so it is now possible to give a detailed description of the species and to remove a certain amount of confusion from the taxonomy of the genus.

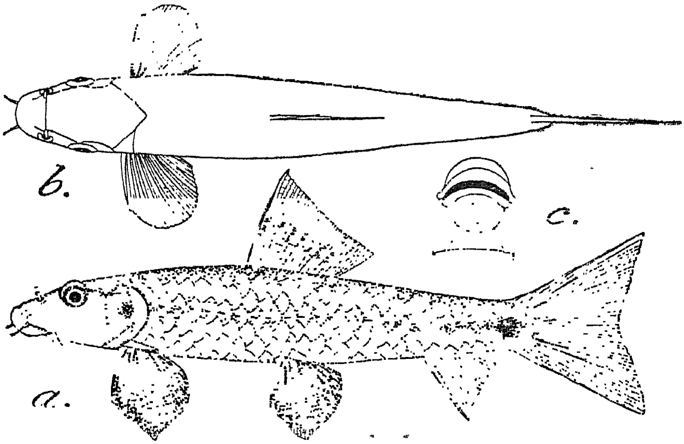
Hamilton's description of *G. lamta* is of a very generalised type, but attention may be directed to the following salient features as noted by him :—

1. Pectoral fins sharp in the middle.
2. Grows to about three inches in length.
3. A faint spot on each side towards the end of the tail.
4. Dorsal fin before the middle.
5. Pectoral fins nearly as long as the head.

In the manuscript drawing of the species there is an indication of a lateral band about the level of the lateral line which terminates behind in the precaudal spot and extends forwards to the gill-opening. The

1. Hora, *Rec. Ind. Mus.*, XXII, pp. 633-687, pls. xxiv-xxvi (1921).
2. Hamilton, *Fish. Ganges*, pp. 343, 393 (Edinburg : 1822).
3. Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 192 (1929).
4. Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 48 (1934).

fins are grayish with the middle portions of the inter-radial membranes of the dorsal fin marked with black spots.



Text-fig. 9.—Copies of Francis Hamilton's manuscript drawings of *Cyprinus* (*Garra*) *lamta*.

a. Lateral view finished in colour in the original ; *b*. Outline sketch of dorsal view ; *c*. Ventral surface of head, finished in pencil in the original.

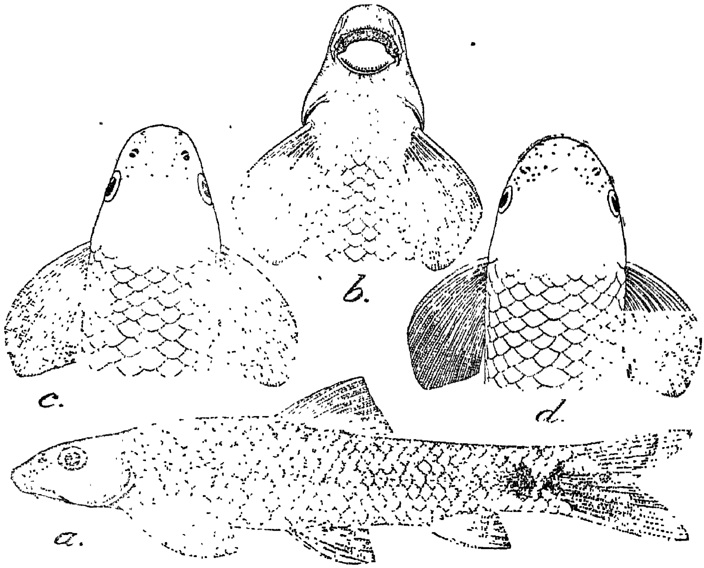
Judging from the characters noted above, there seems no doubt that the material sent by Mr. Das is definitely referrable to *G. lamta* which may now be defined as follows :—

Garra lamta Hamilton.

1822. *Cyprinus* (*Garra*) *lamta*, Hamilton, *Fish. Ganges*, pp. 343, 393.
1838. *Gonorhynchus lamta*, McClelland, *As. Res.*, XIX, p. 282, pl. cliii, fig. 2.
1921. *Garra lamta*, Hora, *Rec. Ind. Mus.*, XXII, p. 660.

Garra lamta is a small species in which both the dorsal and the ventral profiles are somewhat arched. The head and the anterior part of the body are flattened. The head is small, broad and broadly rounded in front ; its length is contained from 4·3 to 4·6 times in the total length and from 4·1 to 4·5 times in the length without the caudal. The head is proportionately longer in younger specimens. The head is relatively narrower in the smaller individuals ; its width is contained from 1·2 to 1·4 times and its height at occiput about 1·3 times in its length. The eye is situated near the dorsal profile of the head and in adult males it is almost in the middle of the head while in females it is nearer to the posterior margin of the operculum than to the tip of the snout. The snout is considerably broader in the females than in the males. The diameter of the eye is contained from 2·5 (in the young) to 3·5 times in the length of the head. In young specimens the diameter of the eye is greater than the length of the snout, but in adults it is about two-thirds of the same dimension. The interorbital distance is only slightly greater than the diameter of the eye in young specimens but with growth it almost becomes double the eye diameter. In the adult

females the interorbital space is somewhat greater than that in the males. The tip of the snout is marked off by two short lateral grooves. There is no proboscis but a few horny tubercles are usually present. The mental disc is relatively small.



TEXT-FIG. 10.—*Garra lamta* Hamilton (Specimen from the Kharagpur Hills, Bihar).

a. Lateral view of a male specimen. Nat. size; *b.* Ventral surface of head and anterior part of body of a male specimen. $\times 1\frac{1}{3}$; *c.* Dorsal surface of head and anterior part of body of a male specimen. $\times 1\frac{1}{2}$; *d.* Dorsal surface of head and anterior part of body of a female specimen. $\times 1\frac{1}{3}$.

The depth of the body varies from 4 to 5·2 times in the total length and from 3·7 to 4·1 times in the length without the caudal. The caudal peduncle is only slightly longer than its height. The body is covered with firmly-set scales which are only faintly marked in the chest region. There are about 32-34 scales along the lateral line and $3\frac{1}{2}$ rows below it to the base of the ventral fins. The rows of scales between the lateral line and base of the dorsal fin varies from $4\frac{1}{2}$ to $5\frac{1}{2}$. The number of predorsal scales is 12. The ventral fin is provided with a scaly appendage at its base.

The dorsal fin commences slightly in advance of the ventrals; its commencement is nearer the tip of the snout than the base of the caudal fin. The longest ray of the dorsal fin is somewhat longer than the head in young specimens and shorter in adults. The pectoral fin is slightly longer than the head and is separated from the ventrals by a considerable distance. The ventrals are considerably nearer the base of the caudal than the tip of the snout; they just extend to the anal opening. The distance between the vent and the base of the anal fin is less than one-third the distance between the commencements of the anal and ventral fins.

The most characteristic feature of the species is its colouration. There is a broad lateral band from behind the gill-openings to the base of the caudal fin where it ends in a rounded spot. It is bordered, both above and below, by light pale stripes. The dorsal surface is grayish and each scale is marked with a dense black dot in the centre of the posterior margin. These black spots form longitudinal stripes. A black spot near the upper angle of the gill-opening is present and the membranes between the dorsal spines, especially near the base, are marked with dark spots. The lateral surface below the lateral line is dusky and so are the dorsal and the caudal fins.

The lateral band and the precaudal spot should enable this species to be readily distinguished.

Measurements in millimetres.

							♂	♂	♀
Total length without caudal . . .	36·0	39·0	45·0	46·0	49·0	51·0	58	65	67
Length of head . .	8·8	9·0	11·0	11·2	11·7	12·0	13·0	14·3	15·0
Width of head . .	6·3	7·0	8·0	9·0	9·2	9·3	10·1	12·0	12·1
Height of head at occiput	7·0	7·3	8·0	8·2	8·5	9·0	10·0	10·5	11·0
Height of body . .	9·0	10·5	11·0	12·2	13·0	13·0	15·0	17·0	17·0
Length of snout . .	3·1	3·0	4·3	4·7	4·9	4·8	5·0	6·0	6·0
Diameter of eye . .	3·5	3·5	4·0	3·9	4·0	4·0	4·25	4·25	4·3
Interorbital width . .	3·9	4·0	5·0	5·0	5·5	6·0	6·0	7·0	7·5
Longest ray of dorsal .	9·0	9·0	11·5	11·2	12·0	13·0	13·7	14·0	13·0
Longest ray of anal . .	7·3	7·5	7·5	8·0	9·0	10·0	11·5	11·0	11·0
Length of pectoral . .	10·0	10·0	11·0	11·2	12·5	14·5	14·5	16·0	15·4
Length of caudal peduncle	5·7	5·8	7·5	8·0	8·0	9·0	9·0	11·0	11·0
Least height of caudal peduncle	5·0	5·0	6·2	6·9	7·0	8·0	8·0	9·0	9·5

Remarks.—From the above it is clear that the small specimens with a median proboscis on the snout, which I[1] had regarded to be the males of this species, do not belong to *G. lamta.* They seem to be similar to the young specimens of *G. gotyla,* which Mukerji and I[2] collected in the Eastern Doons. It was observed by us that " The proboscis is present in both the sexes and even in young specimens, about 53 mm. in total length, it is fairly prominent."

The young specimen recorded by Prashad and Mukerji[3] from the Sankha hill-stream in the Myitkyina District, Upper Burma, as *G. lamta* belongs to *G. gotyla,* as also the specimen reported upon by Mukerji[4] from the Mali Hka river. The last specimen is undoubtedly similar to the form recorded by Vinciguerra[5] as *G. lamta,* but a detailed study of the specimens has shown that they belong to *G. gotyla.* The proboscis is broad and massive in these specimens and is anteriorly lobed

[1] Among the specimens I had referred to *G. lamta* in 1921, I find that there are only four, 1 from the Man river and 3 from the Katin nallah, which belong to this species while all the others are young of *G. gotyla.*
[2] Hora & Mukerji, *Rec. Ind. Mus.,* XXXVIII, p. 144 (1936).
[3] Prashad & Mukerji, *Rec. Ind. Mus.,* XXXI, p. 192 (1929).
[4] Mukerji, *Journ. Bombay Nat. Hist. Soc.,* XXXVII, p. 48 (1934).
[5] Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2), IX, p. 275 (1890).

by the presence of the hard, horny tubercles. In the Indian specimens of *G. gotyla* the proboscis is narrower and projects forward as a short cylinder. It is probable that when further material becomes available from Burma it may have to be regarded as a separate species, but in the present state of our knowledge such a course is not justified. *G. gotyla* is known from the Chindwin and Irrawadi drainage systems (*vide supra*, p. 333); its range extends all along the Himalayas. Deraniyagala[1] found a closely allied form in Ceylon and in commenting on its relationships I observed (*vide* Deraniyagala, *op. cit.*): "The Ceylonese *G. gotyla*, if I may use this phrase, seems to have evolved the characters of the species independently, so that these two forms are the results of a parallel evolution." In view of certain palaeogeographical considerations[2] I now find that at a certain period the fauna of the Himalayas probably spread along the Satpura trend to the Western Ghats and thence to the hills of the Peninsula and Ceylon. The record of the young specimens of *G. gotyla* from the eastern section of the Vindhyan Range is, therefore, of special significance in this connection. The antiquity of *G. gotyla* is also evident from the fact that, according to Deraniyagala, the young of *G. ceylonensis ceylonensis*, the commonest form of *Garra* in the island, often show the characters of *G. gotyla*.

From the above observations it may be concluded that *G. lamta* is known so far only from the Kharagpur Hills for it is likely that the Rapti river form (Gorakhpore Dist.) may prove to be quite different.

XXXVI.—ON A NEW GENUS OF CHINESE CATFISHES ALLIED TO *Pseudecheneis* BLYTH[3].

In his "Study on some Chinese Catfishes", Tchang[4] recorded *Pseudecheneis sulcatus* (McClelland)[5] from China and very fortunately gave a description and two figures of the single specimen obtained in Yunnan and now preserved in the Zoological Museum of Fan Memorial Institute of Biology, Peiping (No. 12016). The description and figures are so different from those of the form known to me from India and Burma that I wrote to Dr. Tchang for a loan of the interesting specimen for comparison with the numerous topotypes of the species in the collection of the Zoological Survey of India, but in reply he expressed his inability to accede to my request. The Yunnanese example, however, seems to be so different from the Indian species that I have no hesitation in suggesting for it a separate genus **Propseudecheneis** and to christen the species, after the name of its discoverer Dr. T. L. Tchang, **Propseudecheneis tchangi,** sp. nov.

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[1] Deraniyagala, *Ceylon Journ. Sci.* (B), XVII, p. 227 (1933).

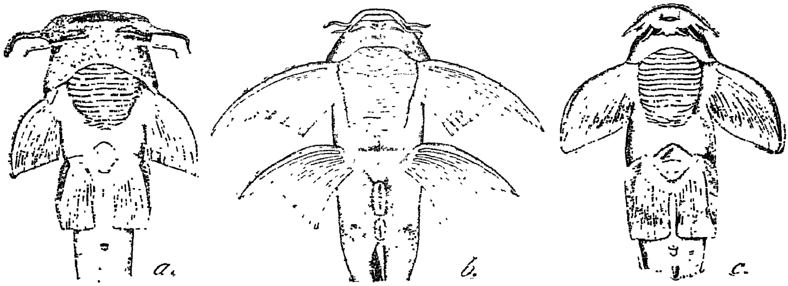
[2] Hora, *Rec. Ind. Mus.*, XXXIX, p. 255 (1937).

[3] The article along with a specimen of *Pseudecheneis sulcatus* (McClelland) was sent in April 1937 to Dr. T. L. Tchang for his comments and its subsequent publication in the Bulletin of the Fan Memorial Institute of Biology. No reply has yet been received and owing to the Sino-Japanese war its publication in China now seems doubtful.

[4] Tchang, *Bull. Fan Memorial Inst. Biol.* (Zool.), VII, p. 47 (1936).

[5] McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584 (1842).

Propseudecheneis can be readily distinguished from *Pseudecheneis* Blyth[1] and *Parapseudecheneis*[2] by the nature of its mouth, lips and



TEXT-FIG. 11.—Ventral surface of head and anterior part of body of *Parapseudecheneis* Hora, *Propseudecheneis*, gen. nov., and *Pseudecheneis* Blyth.

a. Parapseudecheneis paviei (Vaillant); *Propseudecheneis tchangi*, gen. *et* sp. nov.; *Pseudecheneis sulcatus* (McClelland).

Figure *b*. is copied from Dr. T. L. Tchang's drawing.

jaws and also by the form and position of its paired fins. The general build of the body is also different in the three genera. Some of their distinguishing features are tabulated below :—

Propseudecheneis, *gen. nov.*	*Pseudecheneis* Blyth.	*Parapseudecheneis* Hora.
Head and body greatly depressed; head considerably narrower anteriorly with the apex truncate.	Head and body subcylindrical; head broadly rounded anteriorly.	Head and body greatly depressed; head broad and almost truncate anteriorly.
Mouth small, inferior, transverse; lips thick, with small papillae.	Mouth very small considerably behind tip of snout; lips thick, reflected round the mouth and studded with papillae.	Mouth somewhat extensive, sub-inferior; transverse; lips thick and corrugated.
Adhesive disc composed of 21 folds which are probably faintly marked.	Adhesive disc composed of 14-15 prominent folds.	Adhesive disc composed of 10-11 prominent folds.
Outer ventral ray the longest; probably not provided with adhesive folds on ventral surface.	Outer ventral ray short, broad and provided with adhesive folds on ventral surface.	Outer ventral ray short, broad and provided with adhesive folds on ventral surface.

Tchang's description of the unique specimen of *Propseudecheneis* is not sufficiently detailed to institute any further comparison with the other two allied genera, but the figures of the ventral surface of the head and the anterior part of the body of the type-species of *Pseudecheneis* *Parapseudecheneis* and *Propseudecheneis* reproduced here clearly show their principal distinguishing features.

In 1930, I (*op. cit.*, p. 217) regarded *Pseudecheneis* and *Parapseudecheneis* as having been evolved independently under the influence of

[1] Blyth, *Journ. As. Soc. Bengal,* XXIX, p. 154 (1860).
[2] Hora, *Rec. Ind. Mus.,* XXXIII, p. 215 (1930).

some similar factor or factors in their environment, but recently, when I[1] became aware of the probable changes in the drainage system of South-eastern Asia, I considered them to be genetically related. The discovery of the Chinese form lends considerable support to the latter view. Judging from the structure of the three genera, it seems probable that *Propseudecheneis* represents the generalised form and that the other two genera are derived from it under somewhat different sets of environmental conditions. *Parapseudecheneis* appears to have been evolved in somewhat deeper rocky streams with fast currents, such as are now found in the plateau of Central Asia where somewhat similar forms of *Glyptosternum* McClelland, but without the thoracic adhesive apparatus, such as *G. maculatum* (Regan) in Eastern Tibet and *G. reticulatum* McClelland in Eastern Turkestan, Chitral, Afghanistan, Kashmir, etc., are found today. *Pseudecheneis* seems to be specially adapted to live in turbulent waters of small rocky streams of the south-eastern slopes of the Himalayas and the connected chain of hills. I have indicated in several of my earlier works that the " transfer of the adhesive organ from the centre of the animal to the extremities is a remarkable feature of all the hill-stream animals."[2] Such a transfer is well illustrated in the case of the species of *Glyptothorax* Blyth, where in the less specialised forms the adhesive folds are very extensive in the thoracic region but are totally absent from the paired fins. In the highly specialised forms, such as *G. striatus* (McClelland) and *G. pectinopterus* (McClelland), on the other hand, the thoracic apparatus is greatly reduced while the outer rays of the paired fins are provided with adhesive pads. Judging by this criterion alone, *Propseudecheneis* would seem to be the most generalised form, which gave rise to *Pseudecheneis* in India and to *Parapseudecheneis* in Indo-China. *Parapseudecheneis* probably gave rise to *Glyptosternum*-like fishes while the other two genera seem to be the progenitors of a variety of Glyptosernoid fishes found in China, Siam, Burma and India.

It seems to be the case with practically all the present-day freshwater genera of Indian fishes that their ancestral home was in South China or in the case of the mud-loving forms Indo-Chinese region. From these regions the aquatic fauna spread towards the south and west, and the subsequent changes in their environment induced the evolution of a great variety of genera, especially in the regions of the Himalayan upheavals.

Propseudecheneis is found in Yunnan, *Parapseudecheneis* in Tongking and *Pseudecheneis* in Nothern Burma, Assam and the Eastern Himalayas (Brahmaputra Drainage System). The first two genera are thus found in the Red River System, which according to Gregory[3] was once a mighty stream as it comprised the headwaters of the Yangtse-Kiang. The ancestral form of *Pseudecheneis* was probably transferred to Burma and India at a later date through the beheading of the eastern rivers by the younger western rivers which were being produced on the rising slopes of the Himalayas.

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[1] Hora, *Cur, Sci.*, V, p. 354 (1937).
[2] Hora, *Phil. Trans. Roy. Soc. London*, CCXVIII, p. 234 (1930).
[3] Gregory, *Scottish Geog. Mag.*, XLI, pp. 121-141 (1925).

RECORDS

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Notes on Fishes in the Indian Museum. XXIX. On a Collection of Fish from Nepal.

By

SUNDER LAL HORA

CALCUTTA:

MARCH, 1937

NOTES ON FISHES IN THE INDIAN MUSEUM.

XXIX.—On a Collection of Fish from Nepal.

By Sunder Lal Hora, *D.Sc.*, *F.R.S.E.*, *F.N.I.*, *Assistant Superintendent, Zoological Survey of India, Calcutta.*

Nepal is generally regarded as a closed country to travellers and it is no wonder, therefore, that very little is known about its fauna. The lack of knowledge about the ichthyology of the Nepal Himalayas is a great handicap in any discussion concerning the geographical distribution of fishes that have been recorded from the eastern and the western parts of this great mountain chain. In 1907, Regan[1] reported on a small collection of fish obtained from Nepal and recorded the following species :—

1. *Oreinus richardsonii* Gray	Soondrijal hills above Katmandu.
2. *Diptychus annandalei* Regan	Pharping (Katmandu Valley).
3. *Saccorbranchus fossilis* (Bloch) . . .	Katmandu.
4. *Euchiloglanis blythii* (Day)	Pharping.
5. *Ophiocephalus punctatus* Bloch . . .	Pharping.

In 1923, I[2] pointed out that the Nepal specimens referred by Regan to *Euchiloglanis blythii* (Day) did not belong to that species and had to be referred to a new species which I designated as *Glyptosternum hodgarti*. This species is fairly common in the rivers below Darjiling and in the hill ranges of Assam. In 1931, Mukerji[3] discussed the generic position of *Diptychus annandalei* and came to a tentative conclusion that it should be referred to the genus *Schizothorax* or, if the absence of scales turns out to be a constant feature of the adults, to a new genus intermediate between *Schizothorax* and *Diptychus*.

From the beginning of 1935 Colonel F. M. Bailey, Resident at the British Legation, Nepal, has at my request sent four lots of fish from the Nepal territory and these form the subject matter of this note. Though no new species of fish is represented in this valuable collection, I have been enabled to extend the range of the remarkable genus *Semiplotus* Bleeker, which had hitherto been recorded from Burma, the Assam hills and the Darjiling Himalayas and to record variation in colour in the case of *Barilius vagra* Ham. The occurrence of *Labeo dyocheilus* (McClelland) is also of some interest as the species had hitherto been known from the Assam hills on the one hand and Hardwar and Simla on the other.

In all 158 specimens belonging to 22 species were sent by Col. Bailey, but those from Devighat were not in a good condition to be preserved. The remaining specimens have been incorporated in the collection of

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1 Regan, *Rec. Ind. Mus.*, I, p. 157 (1907).
2 Hora, *Rec. Ind. Mus.*, XXV, p. 38 (1923).
3 Mukerji, *Rec. Ind. Mus.*, XXXIII, p. 63 (1931).

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the Zoological Survey of India (Indian Museum). I take this opportunity to offer my sincerest thanks to Col. F. M. Bailey for his kindness in collecting fishes from this interesting area and presenting the same to the Zoological Survey.

The entire material is listed below according to the localities:

Devighat (Lat. 27° 50′, Long. 85° 5′), 2 days march west of Katmandu (April, 1935).
1. *Barilius vagra* Ham. . . . . . . 14 specimens.
2. *Crossochilus latius* (Ham.) . . . . . 1 specimen.
3. *Barbus* sp. (juvenile) . . . . . . 3 specimens.

Hulchok (on Gandak River near Lat. 28° 15′, Long. 84° 50′), 2,500 ft. (10.viii.1935).
1. *Oreinus richardsonii* Gray . . . . . 8 specimens.

Mangning (about Lat. 28° 10′, Long. 85° 10′), 5,000 ft. (13.viii.1935).
1. *Oreinus richardsonii* Gray . . . . . 6 specimens.

Nagarkot, (Lat. 27° 40′, Long. 85° 30′) 5,500 ft. (20.ix.1935).
1. *Oreinus richardsonii* Gray . . . . . 14 specimens.
2. *Nemachilus rupicola* var. *inglisi* Hora . . 5 specimens.

Sundarwal (Central Nepal), 5,500 ft. (20.ix.1935).
1. *Oreinus* sp. (juvenile) . . . . . 6 specimens.

Katmandu, 4,500 ft. (29.ix.1935).
1. *Ophicephalus punctatus* Bloch . . . . 37 specimens.

Tribeni (Lat. 27° 26′, Long. 83° 56′), Nepal Terai (5.xii.1935).
1. *Chela baicala* (Ham.) . . . . . . 1 specimen.
2. *Laubuca laubuca* (Ham.) . . . . . 1 specimen.
3. *Barilius bendelisis* (Ham.) . . . . . 5 specimens.
4. *Barilius tileo* Ham. . . . . . . 9 specimens.
5. *Barilius shacra* Ham. . . . . . . 3 specimens.
6. *Barilius vagra* Ham. . . . . . . 5 specimens.
7. *Barilius (Opsarius) bola* Ham. . . . . 1 specimen.
8. *Aspidoparia jaya* (Ham.) . . . . . 4 specimens.
9. *Aspidoparia morar* (Ham.) . . . . . 6 specimens.
10. *Labeo dero* (Ham.) . . . . . . 1 specimen.
11. *Crossochilus latius* (Ham.) . . . . . 7 specimens.
12. *Barbus putitora* (Ham.) . . . . . 1 specimen.
13. *Nemachilus scaturigina* (McClell.) . . . 1 specimen.
14. *Ailia coila* (Ham.) . . . . . . 10 specimens.
15. *Clupisoma garua* (Ham.) . . . . . 2 specimens.
16. *Xenentodon cancila* (Ham.) . . . . . 4 specimens.

Nepal Terai, near Tribeni (February, 1936).
1. *Labeo dero* (Ham.) . . . . . . 1 specimen.
2. *Labeo dyocheilus* (McClell.) . . . . . 1 specimen.
3. *Semiplotus semiplotus* (McClell.) . . . . 1 specimen.

Barilius vagra Hamilton.

In 1872, Day[1] described *Barilius modestus* from the Indus in Sind and the Ravi River at Lahore. So far as can be judged from its description, he distinguished it from the common *B. vagra* Ham. by the absence of the vertical colour bars. I have examined a typical specimen of the species in the collection of the Indian Museum and have compared it with specimens of *B. vagra*. There are no morphological features on which the two species can be recognised from each other. In Col. Bailey's collection there are 5 specimens from Tribeni which I have referred to *B. vagra*; they lack any colour markings on the body, except that the dorsal surface is grayish and strongly marked off from the silvery sides. The examination of these specimens has convinced me that Day's *B. modestus* is only a colour variant of *B. vagra* and not a distinct species.

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[1] Day, *Journ. As. Soc. Bengal*, p. 4 (1872); *Fish. India*, p. 589, pl. cli, fig. 3 (1878).

To facilitate reference in future I give below a table of measurements of the Nepalese specimens :

Measurements in millimetres.

Total length	59·0	67·0	69·0	84·0	92·5
Length of caudal	10·0	13·5	13·5	18·0	21·3
Length of head	11·0	13·0	13·0	14·3	15·5
Height of head	7·0	8·5	8·8	10·0	11·3
Width of head	5·0	6·0	6·0	7·0	8·0
Diameter of eye	3·0	3·5	3·9	4·0	4·5
Interorbital width	3·3	3·3	4·0	4·3	5·0
Length of snout	3·0	3·8	3·8	3·8	4·0
Height of body	10·0	12·0	11·3	14·0	15·8
Width of body	5·0	6·0	6·0	6·3	7·0
Length of caudal peduncle	7·0	8·0	8·0	8·0	8·5
Least height of caudal peduncle	5·0	6·0	5·5	7·0	7·5
Longest ray of dorsal	9·0	10·0	10·0	11·5	14·0
Longest ray of anal	8·0	8·5	8·5	8·5	12·0
Length of pectoral	9·5	10·0	10·0	13·0	13·4

Labeo dyocheilus (McClelland).

Recently I[1] pointed out the distinguishing features of *Labeo ay* and showed the characters in which it differs from *Labeo dero* (Ham.). At the same time it was indicated that the collection of the Indian Museum contained only 4 specimens of this species—1 from Simla, 1 from Hardwar and 2 from Assam. The addition of one more specimen to the collection from an intermediate region is, therefore, of great value.

Semiplotus semiplotus (McClelland).

us semiplotus was described by McClelland[2] from Assam and placed in the genus *Cyprinus* with only one other Indian species *Catla catla* (Ham.). Bleeker[3] proposed a new genus *Semiplotus* for it and this he defined as follows, presumably without examining any specimen of the species :

" Rostrum integrum lateribus non lobatum. Maxilla superior non protractilis. Ossa nasalia et suborbitalia cum maxilla superiore coalita. Labia continua nec crenata nec fimbriata. Cirri nulli. Pinna dorsalis elongata spina edentula armata, supra analem desinens. Squamae magnae."

Günther[4] recognised Bleeker's genus without any emendation, but he had only one bad skin for examination. In 1870, Day[5] described another species—*S. modestus*—in this genus from the hill-ranges of Akyab and remarked :

" This species appears intermediate between the genera *Semiplotus* and *Cyprinion* ; for it nearly agrees with the former in the slight motion

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[1] Hora, *Rec. Ind. Mus.*, XXXVIII, p. 320 (1936).
[2] McClelland, *As. Res.* (Ind. Cyprinidae), XIX, pp. 274, 346, pl. xxxvii, fig. 2 (1839).
[3] Bleeker, *Atl. Ichth.*, III, p. 25 (1863).
[4] Günther, *Cat. Fish. Brit. Mus.*, VII, p. 204 (1868).
[5] Day, *Proc. Zool. Soc. London*, p. 101 (1870).

of the upper jaw, absence of barbels, etc., whilst it likewise resembles the latter in having a serrated dorsal spine, although it has no bony edge to the lips or barbels."

Chaudhuri[1] described a third species of *Semiplotus*—*S. cirrhosus*—from very young specimens and distinguished it from the other two species by the possession of two small maxillary barbels and by the absence of a knob at the symphysis of the lower jaw. Col. Bailey's specimen from Nepal was identified as *Semiplotus semiplotus* but was found to possess two small maxillary barbels in the groove at the corner of the mouth. This led me to examine other specimens of the species in the collection of the Indian Museum and in every case the maxillary barbels were found to be present. In young individuals they are relatively much longer and project outside the groove whereas in half-grown and adult specimens they are more or less concealed, but it is not very difficult to make them out. Similar barbels are also present in Day's *S. modestus*. It is clear, therefore, that the presence of small, maxillary barbels is a constant feature of the genus. I am of opinion that Chaudhuri's unique specimen of *S. cirrhosus* is only a young of *S. semiplotus*. Day's species with the serrated dorsal spine is, however, quite distinct.

[1] Chaudhuri, *Rec. Ind. Mus.*, XVI, p. 280 (1919).

OBITUARY.

Mr. Dev Dev Mukerji (1903–1937).

WITH deep regret we record the death of Dev Dev Mukerji, Technical Assistant in the Zoological Survey of India, which took place at Calcutta on Thursday, the 21st of January 1937, after a brief illness, at an early age of 34 years.

Dev Dev Mukerji was born in January 1903 at Kharda in the 24-Parganas and after his early education at the village school he was sent to H. C. E. School at Andul from where he passed his Matriculation Examination. In 1919, he joined the St. Xavier's College at Calcutta and four years later passed his B.Sc. Examination with honours in Zoology. In 1925 he took his M.Sc. degree of the Calcutta University in Zoology, and in 1926 joined as an Assistant in the Zoological Survey of India.

Mukerji had a special aptitude for research and a year after his joining the Zoological Survey he published his first paper on two "Pug-headed" specimens of a catfish. Afterwards he worked on several collections from different parts of India in collaboration with the officers of the Department or independently. He was also a keen field zoologist, as is clear from some of his papers.

Mukerji was very methodical, thorough and painstaking in his work and made a very critical study of the data he collected. His published papers show what a commendable amount of research work, besides his heavy routine duties, he was able to do within a short period. At the time of his death he was engaged in preparing a *Bulletin* on Indian freshwater fishes for the Malaria Survey of India, a task of considerable responsibility.

Dev Dev Mukerji was a man of great personal charm and broad sympathies. He was liked by his superiors and colleagues, and in him the Zoological Survey has lost a very able and thoroughly reliable assistant. The science of Zoology, especially ichthyology, has become much poorer to-day by his premature death.

SUNDER LAL HORA.

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Notes on Fishes in the Indian Museum. XXXVIII. On the Systematic Position of *Bagrus lonah* Sykes, with Descriptions of and Remarks on other Glyptosternoid Fishes from the Deccan.

By

SUNDER LAL HORA

CALCUTTA:

DECEMBER, 1938

NOTES ON FISHES IN THE INDIAN MUSEUM.

XXXVIII. On the Systematic Position of *Bagrus lonah* Sykes, with Descriptions of and Remarks on other Glyptosternoid Fishes from the Deccan.

By Sunder Lal Hora, *D.Sc., F.R.S.E., F.N.I., Assistant Superintendent, Zoological Survey of India, Calcutta.*

(Plate VII.)

In his account of the *Fishes of the Dukhun*, Sykes (1841, p. 371) described a Glyptosternoid fish as *Bagrus lonah* and characterised it as follows :—

> " A *Bagrus*, with 8 small *cirri* ; flat, granulated head ; first dorsal fin of 7 rays, and pectoral of 10 rays, the first ray of which is furnished on the posterior edge with long sharp teeth ; anal fin of 10 rays."

As the above synopsis and even Sykes's detailed description of the species are, as judged by modern standards, too generalised, it is not possible to define the precise specific limits of the species. It may, however, be noted that in Sykes's species the head is stated to be " granulated ". Fortunately, Sykes preserved some fishes and along with his account presented them to the Court of Directors of the East India Company in June 1831. For a time, the specimens remained in the Museum at the India House, but were later transferred to the British Museum. In his *Catalogue*, Günther (1864, p. 187) records two Glyptosternoid fishes " From the collection of Colonel Sykes," 6 inches and $3\frac{1}{2}$ inches long respectively. The former is described as *Glyptosternum lonah* (Sykes) and the latter as a new species *G. dekkanense*. As judged from their descriptions the two species differ from each other in the following characters.

G. lonah (Sykes).	*G. dekkanense* (Günther).
1. Head as long as broad.	Head rather longer than broad.
2. Free portion of tail twice as high as long.	Free portion of tail two-thirds as high as long.
3. Dorsal fin higher than body.	Dorsal fin as high as body.
4. Dorsal spine not quite half as long as head.	Dorsal spine half as long as head.
5. Pectoral spine moderately broad, with a fine outer and strong inner serrature.	Pectoral spine very broad and strongly serrated interiorly.

Dr. Trewavas, who very kindly compared the types of the two species for me, noted that " The condition of the outer edge of the spine is similar in both, but in *G. lonah* the skin has been removed, leaving the serrations visible ". The differences in the proportions of the various parts, noted by Günther, seem to fall within the range of individual variation, especially as the two types are of very different sizes and are also in different states of preservation. In view of the above it appeared to me that the two species may be identical, and on this point also Dr. Trewavas agreed and wrote " my conclusion is that *G. dekkanense* may be

identical with *G. lonah* "[1]. A thorough examination of the Glyptosternoid specimens from Peninsular India in the collection of the Zoological Survey of India has also shown that the two forms must be regarded as conspecific.

In 1871, Day (p. 714) extended the range of *G. dekkanense* to the Jumna river "near where it emerges from the Siwalik hills", but later in his *Fishes of India* he combined the two species from Deccan under *G. lonah*, and noted "I have taken this species at Poona, and also in the head waters of the Jumna". In the collection of the Indian Museum there was no named specimen of either of the species from Deccan when I (1923, pp. 8-30) revised the Indian members of the genus *Glyptothorax*. Day's specimen of *G. lonah* from the Jumna was referred to *G. conirostre* (Steind.) and a specimen from the Satara District identified by Annandale (1919, p. 126) as *Euglyptosternum saisii* was described as *G. dekkanense*. Quite recently, however, the Zoological Survey of India received several examples of *Glyptothorax* from Poona and adjacent hill ranges and doubts arose as to the precise specific limits of *G. lonah* (Sykes) and *G. dekkanense* (Günther). A specimen of a species of *Glyptothorax* with smooth skin from Motha Mola river, Poona, was sent to Mr. J. R. Norman for comparison with the types of *G. lonah* and *G. dekkanense*. Dr. E. Trewavas very kindly attended to this enquiry and replied as follows :—

"Your problem is made more difficult of solution by reason of the poor state of preservation of the type of *Glyptosternum lonah*. But the type of *G. dekkanense* is well preserved, and my conclusion is that *G. dekkanense* may be identical with *G. lonah*, and that in *any* case your Motha Mola R. specimen belongs to neither species for the following reasons :—

(*a*) The skin of the body in *G. dekkanense* is tuberculated, that of the head is finely granular. It is difficult to judge the nature of the skin in the emaciated type of *G. lonah*, but there appear to be signs of tuberculation. The skin of Motha Mola fish is smooth.

(*b*) The adhesive apparatus in *G. lonah* and *G. dekkanense* is longer than broad. In the Motha Mola fish it appears to be broader than long.

(*c*) The caudal, twice as long as deep in the Motha Mola fish is $1\frac{5}{12}$ times as long as deep in the type of *G. dekkanense*. That the ratio is also 2 in *G. lonah* may be partly due to emaciation ;—the ends of both dorsal and haemal spines project.

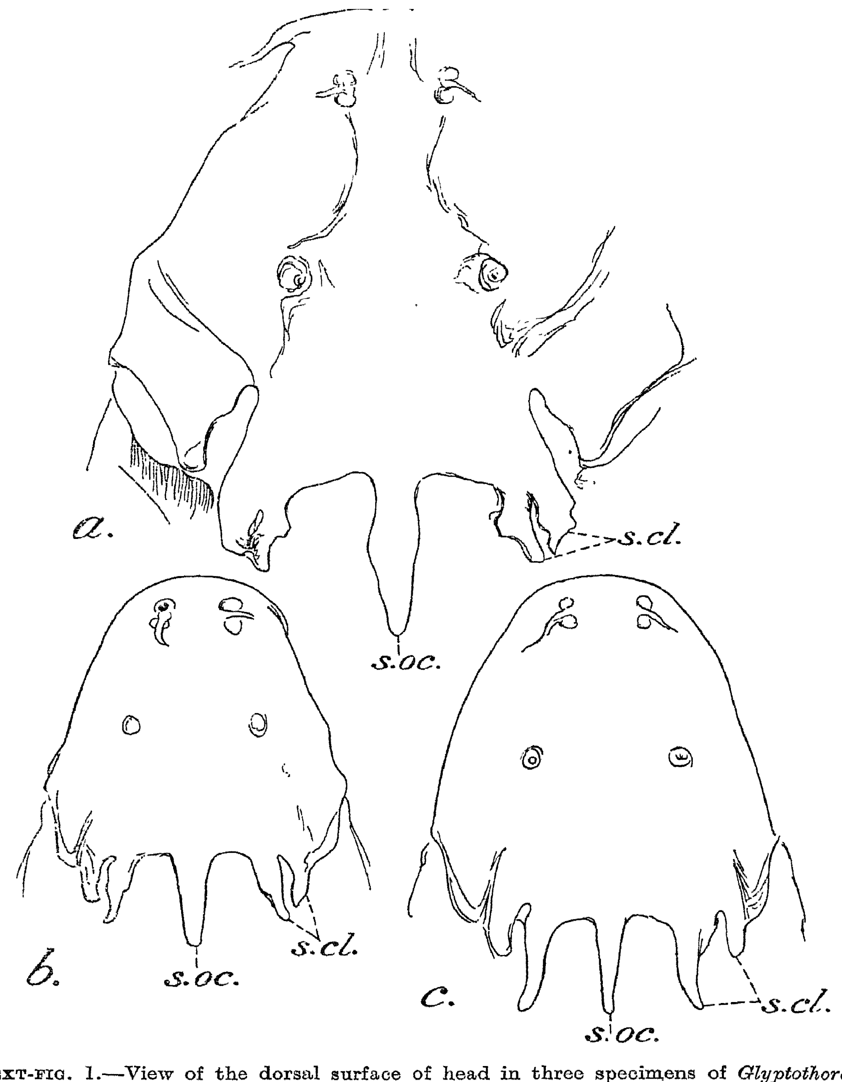
(*d*) The shape of the supracleithrum, as seen or felt through the skin, is of one sort in *G. lonah* and *G. dekkanense* and of another in the Motha Mola fish, in Day's Jumna R. fish and in three (coll. Day) from Poonah.

The inner limb of the forked supracleithrum is much longer than the outer and as long as the supraoccipital spine in the Motha Mola fish, whereas in *G. dekkanense* it is not much longer than the outer limb and is considerably shorter than the supraoccipital spine. I send herewith sketches drawn to scale to illustrate this.

Three specimens, 39 to 52 mm. in standard length collected by Day at Poonah, seem to agree very well with the Motha Mola fish. They are labelled *G. lonah*. Another labelled *G. dekkanense*, from the Jumna R. (coll. Day) looks to me to be also very much like your fish. It is very much emaciated. The pectoral spine is relatively longer and more coarsely serrated."

[1] On a request being made to give reasons for her conclusions Dr. Trewavas very kindly supplied the following information :—" The type of *G. lonah* resembles that of *G. dekkanense* in all characters (tuberculation of skin, shape of adhesive apparatus, shape of head and shape and proportions of supracleithrum) except size of fish (*G. lonah* 128 mm., *G. dekkanense* 68 mm. standard length) and proportions of caudal peduncle. The apparent slenderness of *G. lonah* is partly due to extreme emaciation but also the relative length of the caudal peduncle is greater in *G. lonah* than in *G. dekkanense* ($5\frac{1}{3}$ times in standard length in *G. lonah*, $5\frac{2}{3}$ times in *G. dekkanense*, measured from base of anal to end of last vertebra. Whether or not this can be accounted for by the difference in size I cannot say, and I believe that only the examination of large numbers of specimens from the Deccan can really decide whether these represent two species or one."

From Dr. Trewavas's remarks it appears that the smooth-skinned specimens of the Motha Mola river are similar to those which Day (1871,



TEXT-FIG. 1.—View of the dorsal surface of head in three specimens of *Glyptothorax* from Deccan, showing the shape of the surpacleithrum. Only the bases of the nasal barbels are shown. (From sketches supplied by Dr. E. Trewavas.)

a. Type of *G. lonah* (Sykes). $\times 2\frac{2}{3}$; *b.* Type of *G. dekkanense* (Günther). $\times 2\frac{2}{3}$; *c.* Motha Mola river specimen of *G. conirostre* var. *poonaensis*, nov. $\times 2\frac{2}{3}$ *s. cl.* Supracleithrum ; s.*oc.* Supraoccipital process.

G. 714 ; 1877, p. 496) had collected in the Jumna river and referred to p. *lonah* and *G. dekkanense*. In my earlier work (1923, p. 30) I indicated

that one of Day's specimens of *G. lonah* from the headwaters of the Jumna river, now preserved in the collection of the Indian Museum, was referrable to *G. conirostre* (Steind.), but as there is a close similarity between the Jumna river form and the smooth-skinned form from Poona, the range of *G. conirostre* must be extended to Deccan. A more detailed comparison of the specimens from the two localities shows that the head is proportionately broader and the dorsal fin shorter in the Deccan examples.

Owing to the inadequacy of the material of *Glyptothorax* from the headwaters of the Jumna in the collection of the Indian Museum, a specimen of the Deccan form of *G. conirostre* was sent to Dr. Trewavas for comparison with Day's material from Poona and the Jumna river. Her report is as follows :—

"Specimen F $\frac{12126}{1}$ labelled 'Deccan form of *Glyptothorax conirostre* (Steind.)' agrees well with Day's '*G. lonah*' from Poonah. Compared with Day's '*Glyptosternum dekkanense*' from Jumna R. (which I think you are right in referring to *G. conirostre*) it has, as you point out, a somewhat broader head and lower dorsal fin. These two fishes are of approximately the same size. If now Day's '*Glyptosternum lonah*' from Poonah are compared with specimens of *G. conirostre* of their size from Simla the same difference in width of head is observed. The difference in height of dorsal seems less constant. Therefore, it seems certain that the Motha Mola fish and Day's '*G. lonah*' from Poonah are conspecific, and are distinct from *G. conirostre*; whether specifically or subspecifically only more material can show."

The Poona specimens of *G. conirostre* would thus seem to represent a geographical race of the Jumna form, and to indicate the differences between the two types I propose to describe the Poona race as a distinct variety (*vide infra*, p. 368).

The extension of the range of *G. conirostre* from the headwaters of the Jumna river to the Western Ghats is of considerable interest. In one of my (1938, p. 169) recent contributions the probable route along which the species from the Eastern Himalayas seem to have migrated to the Western Ghats and thence to the hills of Peninsular India was indicated. *G. lonah* (=*G. dekkanense*), which has recently been obtained from the Bastar State[1], Central Provinces, (Hora 1938 *b*, p. 241) would thus appear to have migrated along the Satpuras to the Western Ghats.

The Western Ghats had also a connection with the Western Himalayas in the direction from Gujrat to Delhi through the intermediation of the Aravalli Mountains (Heron 1938, p. 119). The distribution of *G. conirostre* to the Deccan may thus have been effected along the Aravalli range.

It is probably due to these two routes of migrations of the hill-stream fauna from the north to the south that in the South Indian fish-fauna both the Eastern and the Western Himalayan forms are represented.

The specimen of Annandale's (1919, p. 126) *Euglyptosternum saisii* from the Satara District, as indicated above, was referred by me (1923,

[1] A specimen, about 3·5 inches in length, from the Bastar State was sent to Dr. Trewavas, under the title *Glyptothorax dekkanense*, for comparing it with the type of Günther's species. She found the two specimens identical in every respect.

p. 24) to *Glyptothorax dekkanense*, and later another specimen from the Tunga river at Shimoga (No. F 12435/1), owing to its strong resemblance to the Satara specimen, was assigned to the same species (Hora 1937, p. 14). The latter example, under the title *G. lonah*, was sent to Dr. Trewavas for comparison with the types of *G. lonah* and *G. dekkanense* and she has kindly favoured me with the following report :—

"Comparison of the type of *G. lonah* and your specimen so labelled is less satisfactory as both are in a poor state. What strikes me is that although your fish (F $\frac{12435}{1}$) is shorter than the type it has a longer head, and also stronger inner serrae on the pectoral spine. The depth of its caudal peduncle is only $\frac{3}{4}$ of that of the type, which is less than one would expect even if the type were not emaciated. The maxillary barbel in your fish barely reaches the base of the pectoral, in the type it extends beyond it. I am satisfied that F $\frac{12435}{1}$ is distinct from *G. lonah* but not that it is identical with *G. dekkanense*."

These specimens are quite different from the other species found in India, and in view of the above opinion it seems necessary to separate them as a new species.

Misra and I (1938, p. 36) referred a specimen of *Glyptothorax* from the headwaters of the Godavari river to *G. annandalei* Hora, but I am of opinion that it should be referred to *G. lonah*. As Günther had included both *G. lonah* and *G. dekkanense* under the division characterised by "Ventral and pectoral rays not plaited below", the close association of *G. annandalei*, in which the outer pectoral and ventral rays are plaited on the ventral surface, with *G. lonah* never occurred to me. I now find that the plaited condition of the rays of the paired fins may be an ecological character depending upon the rapidity of the water in which the fish may be living. Similar ecological races were indicated by me in the case of *Garra mullya* (Hora 1921, p. 659) and by Day (1871, p. 714) in the case of *Glyptothorax*. I think, however, that one should recognise local races based on geographical or ecological considerations. In view of the above, I am of the opinion that *G. annandalei* Hora, with a much longer and narrower caudal peduncle, probably represents a torrential race of *G. lonah* (Sykes), but in the present state of our knowledge it may be retained, for the time being at least, as a separate species. In *G. annandalei* the outer border of the pectoral spine is finely serrated and the caudal peduncle is at least twice as long as high. In all the fresh specimens of *G. lonah* that I have examined the outer rays of the paired fins are faintly or distinctly plaited below.

Besides the species referred to above, *G. madraspatanus* (Day) is the only other species of *Glyptothorax* found in South India. It agrees with *G. lonah*, the new species from Satara, and *G. annandalei* in possessing a tuberculated body, but differs in having relatively longer fins and stronger spines. In *G. madraspatanus* the pectorals are as long as or slightly longer than the head and the dorsal spine is serrated along both the borders near the apex ; the serrae are, however, more pronounced along the posterior border.

From the above it is clear that at present five species of *Glyptothorax* can be recognised from Peninsular India, *viz.*, *G. lonah* (Sykes), *G. madraspatanus* (Day), *G. annandalei* Hora, *G. conirostre* (Steind.) var.

poonaensis nov. and *G. trewavasae*, sp. nov. They may be distinguished by the following key :—

1. Skin smooth .. .. *G. conirostre* var. *poonaensis*, nov.
2. Skin tuberculated
   - I. Pectoral spine almost as long as head, or somewhat longer; dorsal spine strong and serrated near the apex .. .. *G. madraspatanus* (Day).
   - II. Pectoral spine not as long as head, generally considerably shorter; dorsal spine moderately developed and smooth throughout
     - A. Maxillary barbels extending considerably beyond commencement of pectoral
       - i. Caudal peduncle about $1\frac{1}{2}$ times as long as deep .. .. .. *G. lonah* (Sykes).
       - ii. Caudal peduncle at least 2 times as long as deep .. .. .. *G. annandalei* Hora.
     - B. Maxillary barbels barely reaching base of pectoral .. .. *G. trewavasae*, sp. nov.

An analysis of the geographical distribution of the above mentioned 5 species is of some interest. *G. conirostre* var. *poonaensis* has so far been recorded only from the waterways near Poona, but as its closely allied form is found in the Jumna river, it is likely to be met with in the intermediate regions. *G. lonah* is known from the Godavari watershed (Nasik and Bailadila range) and the Kistna watershed (Poona). *G. trewavasae* is found only in the Kistna watershed, while the remaining two species, *G. madraspatanus* and *G. annandalei*, occur in the Cauvery watershed. So far, *G. lonah* is the only species that is known to occur in the two adjacent watersheds and over a much wider area.

Glyptothorax conirostre var. **poonaensis**, nov.

(Plate VII, figs. 5 and 6.)

1877. *Glyptosternum lonah*, Day (in part, *nec* Sykes), *Fish. Ind.*, p. 496, pl cxiii, fig. 5.

D. 1/6|0 ; A. 10 ; P. 10 ; V. 6 ; C. 17.

The head and the anterior part of the body are moderately depressed, and the tail region is compressed from side to side. The skin, both on the head and the body, is smooth. The snout tapers broadly towards the anterior end. The head is distinctly longer than broad ; its length is contained from 4·2 to 4·3 times in the standard length. The eyes are small, dorso-lateral in position, and situated in the posterior half of the head. The occipital process is long and narrow ; it is almost twice as long as broad at its base ; it is separated from the basal bone of the dorsal fin by a short distance. The nasal openings are situated slightly behind the tip of the snout and are separated by small barbels, which do not extend as far as the eyes. The mouth is ventral, transverse and crescentic ; its gape is almost equal to half the width of the head. The lips are thin, slightly papillated and continuous at the angles of the

mouth. The labial groove is widely interrupted. The posterior jaw is almost truncate in the middle. A portion of the upper jaw and dentition are bare. The teeth are small and villiform. The gill-openings are wide, and the gill-membranes meet the isthmus in the mid-ventral line. The thoracic adhesive apparatus is considerably longer than broad, but the ridges are only developed in the peripheral region. The maxillary barbels possess broad bases, and extend considerably beyond the commencement of the pectoral fins. The two pairs of mandibular barbels are considerably shorter.

The height of the body varies considerably : it is contained from 5·8 to 7·0 times in the standard length. In the case of mature females (Pl. VII, fig. 5) the body is considerably distended with gonads. The caudal peduncle is short, but narrow ; its least height is contained about 2 times in its length. The rayed dorsal fin commences above the pectorals ; its commencement is almost equidistant between the tip of the snout and the adipose dorsal. The dorsal fin is slightly higher than the depth of the body, but in fully mature females the body is somewhat deeper ; its spine is strong, smooth, and almost half as long as the length of the head. The pectoral fin is shorter than the head ; its spine is strong and pectinated internally ; it is somewhat roughened along the outer edge. The pectoral fin is separated from the ventral fin by a considerable distance. The ventrals are considerably shorter than the pectorals and extend as far as or slightly beyond the anal opening, but are separated from the anal fin by a considerable distance. In the specimens examined by me the paired fins are devoid of the usual adhesive pads on the ventral surface of their outer rays. The anal fin is short and situated below the adipose dorsal. The caudal fin is deeply forked and both the lobes are of equal length.

In the material before me the general colour is light dusky above and dirty white below. The whole of the dorsal surface of the head and body is studded with minute, black dots. In some specimens there are three, saddle-shaped bands across the dorsal surface ; the first across the occipital process and the basal bone of the dorsal fin, the second at the base of the dorsal fin and the third across the base of the adipose dorsal. There is generally a band at the base of the caudal fin. The distal part of the caudal fin is infuscated with black, as also the distal portion of the anal fin.

Locality.—Poona and its environs.

Type-specimen.—Holotype No. F 12126/1 Zoological Survey of India (*Ind. Mus.*), Calcutta.

Remarks.—I have examined 5 specimens of the new variety, 4 from Motha Mola river near Poona collected by Mr. C. V. Kulkarni, Department of Fisheries, Bombay and 1 from the Motha Molla R. near Kharadigaon, Poona, collected by Mr. A. G. L. Fraser. According to Mr. Fraser this species is locally known as *Phather Chatoo*, in which reference is made to the stone-licking habits of these fishes.

Reference has been made above (*vide supra*, p. 366) to the great resemblance of this fish to *G. conirostre* from the Jumna river, and the characters by which it may be distinguished from the typical form.

To facilitate reference, measurements of the two specimens from the Jumna river are also included in the table given below.

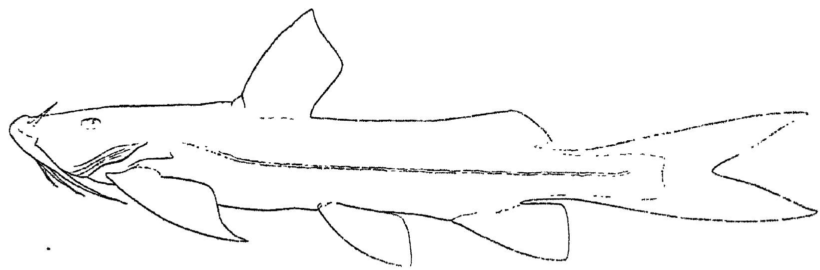
Measurements in millimetres.

	G. conirostre var. *poonaensis.*			*G. conirostre.*	
Total length excluding caudal	81·0	79·5	79·0	107·0	74·5
Length of caudal	17·3	21·5	18·2	28·0	..
Length of head	19·0	18·6	19·0	24·8	16·5
Width of head	15·0	16·6	16·7	18·0	12·3
Height of head	9·8	11·2	10·0	13·0	9·0
Length of snout	10·2	8·3	9·0	12·0	8·9
Interorbital width ..	5·0	5·4	5·0	5·0	4·5
Depth of body	12·0	14·0	11·2	17·0	10·6
Height of dorsal fin ..	13·5	14·2	12·6	21·0	15·0
Length of pectoral fin ..	18·5	17·3	16·0	26·0	18·0
Length of ventral fin ..	13·0	13·6	11·2	18·0	14·0
Longest ray of anal fin ..	10·4	13·0	10·5	20·0	14·2
Length of dorsal spine ..	10·0	10·0	10·0	14·5	11·0
Length of caudal peduncle ..	14·0	13·2	13·8	21·8	16·5
Least height of caudal peduncle	6·8	6·7	6·2	9·8	6·8

Glyptothorax madraspatanus (Day).

1867. *Glyptosternum lonah*, Day (*nec* Sykes), *Proc. Zool. Soc. London*, p. 285.
1873. *Glyptosternum madraspatanum*, Day, *Journ. Linn. Soc. London* XI, p. 526.
1877. *Glyptosternum madraspatanum*, Day, *Fish. India*, p. 498, pl. cxvi, fig. 4.
1889. *Glyptosternum madraspatanum*, Day, *Faun. Brit. Ind., Fish.* I, p. 200.
1923. *Glyptothorax madraspatanus*, Hora, *Rec. Ind. Mus.* XXV, p. 29.
1937. *Glyptothorax madraspatanus*, Hora, *Rec. Ind. Mus.* XXXIX, p. 19.

Since 1923, when I made some remarks on *Glyptothorax madraspatanus*, the species has also been reported from the Cauvery river in the



TEXT-FIG. 2.—Lateral view of a specimen of *Glyptothorax madraspatanus* (Day) from the Cauvery river, Coorg State. × ⅔.

Coorg State. The skin is coarsely tuberculated in all the 8 specimens now represented in the collection of the Zoological Survey of India and the pectoral and the dorsal fins are proportionately much longer in this species. The dorsal and the pectoral spines are also longer and stronger. Further, the dorsal spine is serrated near the apex along both the borders.

Glyptothorax lonah (Sykes).

(Plate VII, figs. 1 and 2.)

D. 1/610 ; A. 11 ; P. 9 ; V. 6 ; C. 16.

1841. *Bagrus lonah*, Sykes, *Trans. Zool. Soc. London* II, p. 371.
1864. *Glyptosternum lonah*, Günther, *Cat. Fish. Brit. Mus.* V, p. 187.
1864. *Glyptosternum dekkanense*, Günther, *Cat. Fish. Brit. Mus.* V, p. 187.
1937. *Glyptothorax lonah*, Hora & Misra, *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 513.
1938. *Glyptothorax annandalei*, Hora & Misra (*nec* Hora), *Journ. Bombay Nat. Hist. Soc.* XL, p. 36, pl. iii, figs. 3, 3a.
1938. *Glyptothorax dekkanensis*, Hora, *Rec. Ind. Mus.* XL, p. 241.

Glyptothorax lonah is a stoutly-built species, in which both the dorsal and the ventral profiles are slightly arched. The head and the anterior part of the body are somewhat depressed and the ventral surface is flattened ; the body is compressed in the tail region. The skin, particularly on the head, is distinctly granulated. The head is somewhat longer than broad ; its length is contained from 4·1 to 4·4 times in the standard length. The eyes are small, dorso-lateral, and situated in the posterior half of the head. The snout is broad and rounded ; it is equal to half the length of the head. The inter-orbital width is equal to one-third the length of the head. The occipital spine is long and narrow ; it almost extends to the basal bone of the dorsal fin. The nasal openings are well-marked and situated slightly behind the tip of the snout ; they are separated by the nasal barbels which do not extend to the eyes. The mouth is ventral, transverse and crescentic ; its gape is almost equal to half the width of the head. The anterior lip is thickly beset with papillae, which are indistinctly marked on the posterior lip. The two lips are continuous at the angles of the mouth. The labial groove is narrow and widely interrupted in the middle. A portion of the anterior jaw and dentition is not covered by the posterior jaw. The teeth are small and villiform. The gill-openings are wide and the gill-membranes are united to the isthmus which is half as wide as the gape of the mouth. The adhesive apparatus on the chest and the ventral surface of the outer rays of the paired fins is fully developed ; the thoracic apparatus is longer than broad and is almost filled with ridges to the mid-ventral line. The maxillary barbels possess broad bases, and extend considerably beyond the commencement of the pectoral fins. The two pairs of mandibular barbels are considerably shorter.

The height of the body is contained from 5·1 to 5·8 times in the standard length. The least height of the caudal peduncle is contained from 1·5 to 1·7 times in its length.

The dorsal fin commences above the pectorals and considerably in advance of the ventrals ; it is almost equidistant between the tip of the snout and the origin of the second anal ray. It is as high as the length of the head behind the nostrils, and is either equal to or slightly shorter or longer than half the length of the head and is usually clothed in thick skin. The pectoral fin is almost as long as the head ; its spine is strongly pectinated internally and finely serrated along the outer border. Usually the spine is covered by thick skin and the outer serrations cannot be made out without dissection. The pectoral fin is separated

from the ventral by a distance equal to the distance between the eye and the nostrils. The ventrals are considerably shorter than the pectorals, but extend beyond the anal opening and miss the anal fin by a very short distance. The anal fin is short and a part of it is situated below the adipose dorsal. The caudal fin is deeply forked ; the upper lobe being somewhat more developed than the lower.

The general colour of the spirit specimens is greyish above and dirty-white below. There is a white streak along the lateral line, and the bases of the fins are generally of a dark colour. The ventrals, anal and caudal fins are provided with black patches in their distal portions. In the smaller individuals, the general colouration is somewhat lighter, but the dark markings are better pronounced.

Localities.—The precise locality of Sykes's specimens is not known, but in the British Museum Catalogue they are noted to have been collected in "Dekkan". The above description is based on the 4 specimens collected by Mr. H. Crookshank from the Galli Nalah near Loa, Bailadila range, Bastar State, Central Provinces. One of these specimens was compared by Dr. Trewavas with the type of *G. dekkanense* and found to be identical with it. Besides these example, 6 more, somewhat smaller, specimens were collected by Mr. Crookshank from another part of the Bailadila range. There are three more specimens of *G. lonah*, collected by Mr. A. G. J. Fraser, one from the Godavari river near Nasik and two from the section below Fitzgerald Bridge, Poona ; these specimens are of small size.

Remarks.—The precise systematic position of the species has been fully discussed above (*vide* p. 367). It can be readily distinguished by its broad caudal peduncle.

Measurements in millimetres.

Total length excluding caudal	83·0	78·0	71·0	70·0
Length of caudal	21·0	21·0	Damaged	20·6
Length of head	19·0	18·5	17·1	17·1
Width of head	16·7	16·0	14·0	14·0
Height of head	12·0	11·5	10·5	9·5
Length of snout	10·0	8·2	8·6	8·7
Interorbital width	6·2	5·8	6·3	5·6
Depth of body	15·0	13·9	12·3	13·8
Height of dorsal fin	15·0	16·1	12·5	12·5
Length of pectoral fin	20·0	18·0	17·0	16·1
Length of ventral fin	15·5	14·5	13·5	13·9
Longest ray of anal fin	14·0	14·5	13·0	14·2
Length of dorsal spine	11·2	10·8	9·5	8·2
Length of caudal peduncle	15·0	14·6	12·2	11·4
Least height of caudal peduncle	10·0	8·7	7·5	7·3

Glyptothorax annandalei Hora.

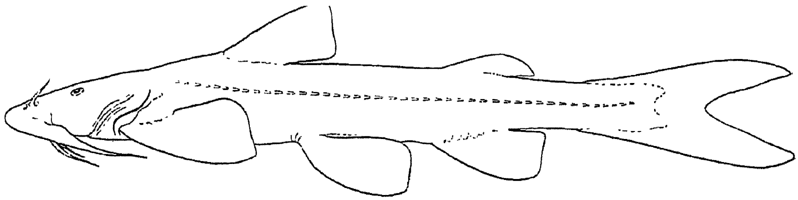
1923. *Glyptothorax annandalei*, Hora, *Rec. Ind. Mus.* XXV, p. 14, pl. i, fig. 3.

In 1923, I included a reference by Day[1] to *Glyptosternum lonah* from the Bhavani river in the synonymy of *Glyptothorax annandalei*,

[1] Day, F., *Proc. Zool. Soc. London*, p. 285 (1867).

but now it seems that the record may refer to *G. madraspatanus* which was described later by Day[1] from the same locality.

G. annandalei is closely allied to *G. lonah*. Its pectoral and the dorsal spines are enveloped in skin, but on dissection the outer border



TEXT-FIG. 3.—Lateral view of a specimen of *Glyptothorax annandalei* Hora. Nat. size.

of the pectoral spine was found to be finely serrated. The head and body distinctly tuberculated, and the skin in the region of the lateral line is raised as a ridge.

In the depressed form of its body, the development of the adhesive pads on the chest and the ventral surface of the outer rays of the paired fins, and the form of the caudal peduncle *G. annandalei* appears to be the most highly specialised torrential species of *Glyptothorax* in Peninsular India.

Glyptothorax trewavasae, sp. nov.

(Plate VII, figs. 3 and 4.)

1919. *Euglytosternum saisii,* Annandale (*nec* Jenkins), *Rec. Ind. Mus.* XVI, p. 126.
1923. *Glyptothorax dekkanensis,* Hora (*nec* Günther), *Rec. Ind. Mus.* XXV, p. 24, fig. 3.
1937. *Glyptothorax dekkanensis,* Hora (*nec* Günther), *Rec. Ind. Mus.* XXXIX, p. 14.

In *Glyptothorax trewavasae* the dorsal profile is almost straight and horizontal and the ventral profile is slightly arched. The head and the anterior part of the body are depressed, and the ventral surface is somewhat flattened. The tail region is only compressed. The skin is finely granulated. The head broadly tapers anteriorly, and the snout is rounded. The head is considerably longer than broad ; its length is contained from 3·8 to 4·0 times in the standard length. The eyes are small, dorso-lateral, and situated in the posterior half of the head. The interorbital space is somewhat greater than half the length of the snout. The occipital process is rectangular ; it is almost 3 times as long as broad at its base and does not extend to the basal bone of the dorsal fin. The nostrils are well-marked and are situated slightly behind the tip of the snout. The nasal barbels are small and do not reach the anterior margins of the eyes. The mouth is ventral, transverse and horizontal ; its gape is equal to half the width of the head. The lips are thin and slightly tuberculated. They are continuous at the angles of the mouth. The

[1] Day, F., *Journ. Linn. Soc. London* XI, p. 526 (1873).

labial groove is quite extensive and is only interrupted for a short distance in the middle. A portion of the anterior jaw and dentition are not covered by the posterior lip. The teeth are small and villiform. There are sharp, horny tubercles on the palate but no teeth. The gill-openings are wide and the isthmus is very narrow. The adhesive apparatus on the chest is almost as wide as long, and extends forwards to a point in between the union of the gill-membranes to the isthmus. The ventral surface of the head is ridged, grooved and papillated, and probably helps in adhesion. The outer rays of the paired fins in the preserved material before me are not provided with adhesive pads. The maxillary barbels barely extend to the roots of the pectoral fins, while the two pairs of the mandibular barbels are considerably shorter.

The height of the body is contained from 6 to 7 times in the standard length. The least height of the caudal peduncle is contained from 1·7 to 2·6 times in its length ; the caudal peduncle becomes narrower with growth.

The dorsal fin commences above the termination of the pectorals ; its commencement is almost equidistant between the tip of the snout and the base of the adipose fin. The dorsal fin is longer than the depth of the body below it ; its spine forms a strong, smooth prickle, which is almost equal to the length of the snout. Except in a young specimen, the pectoral fin is shorter than the head ; it possesses a broad, strong spine which is strongly pectinated internally and is distinctly serrated along the outer border. The pectorals are separated from the ventrals by a distance almost equal to half of their lengths. The ventrals extend beyond the anal opening but are separated from the anal fin by a considerable distance. The anal fin is short and commences slightly in advance of the adipose dorsal. The caudal fin is deeply forked.

The colouration is uniformly light grey with the bases of the pectoral, dorsal, adipose and caudal fins dark. Portions of certain rays in the dorsal, anal and ventral fins are infuscated with black. The distal portion of the caudal fin is dark, it is tipped with a lighter colour.

Localities.—Yenna and Koyna valleys in the Satara District, Bombay Presidency ; and the Tunga river at Shimoga in the Mysore State. The waters from these regions drain into the Kistna river.

Type-specimen.—Holotype No. F 9723/1, Zoological Survey of India (*Ind. Mus.*), Calcutta.

Remarks.—The above description is based mainly on the type-specimen from the Yenna Valley collected by the late Dr. N. Annandale. In a smaller specimen from the Koyna Valley the proportions of the various parts are different, as is also their structure, but in all essential features it seems to represent the species described above. The thoracic adhesive apparatus is considerably longer than broad and the labial grooves are not so extensive. The isthmus is also fairly wide, and the barbels are proportionately longer. The tuberculation on the skin is very faintly marked.

The Tunga river specimen, which I refer to *G. trewavasae*, is partly damaged as Mr. Bhimachar took out the brain of the fish for his studies.

Measurements in millimetres.

	ıyna lley.	Yenna Valley, Type.	Tunga River, Shimoga
Total length excluding caudal	44·1	97·0	113·0
Length of caudal ..	13·9	24·0	27·0
Length of head ..	11·0	25·0	29·7
Width of head ..	9·0	20·0	24·0
Height of head ..	6·0	13·0	13·0
Length of snout ..	5·7	12·0	17·2
Interorbital width ..	3·5	6·7	8·4
Depth of body ..	6·2	15·1	19·1
Height of dorsal fin ..	9·5	16·8	22·0
Length of pectoral fin ..	11·2	18·1	25·0
Length of ventral fin ..	7·9	15·5	19·0
Longest ray of anal fin ..	9·1	15·5	18·1
Length of dorsal spine ..	5·7	12·4	16·2
Length of caudal peduncle	7·7	16·7	21·2
Least height of caudal peduncle	4·5	8·2	8·1

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Notes on Fishes in the Indian Museum. XXXVII. On a Collection of Fish from the Bailadila range, Bastar State, Central Provinces.

A new name for *Silurus sinensis* Hora.

By

SUNDER LAL HORA

CALCUTTA:

SEPTEMBER, 1938

NOTES ON FISHES IN THE INDIAN MUSEUM.

XXXVII. On a Collection of Fish from the Bailadila range, Bastar State, Central Provinces.

By Sunder Lal Hora, *D.Sc., F.R.S.E., F.N.I., Assistant Superintendent, Zoological Survey of India, Calcutta.*

During the field-season of 1937-38, Mr. H. Crookshank, Superintending Geologist, Geological Survey of India, at the author's request, made a small collection of fish from the Bailadila range, Bastar State (17° 46′ and 20° 14′ N. and 80° 15′ and 82° 15′ E.), Central Provinces. The Bailadila range is situated to the south of the Indravati river, a tributary of the Godavari, and runs through the centre of the Bastar State from north to south; its highest peak is about 4,000 feet above sea-level. Mr. Crookshank made his collection from four different streams and noted the ecological conditions of their waters. The species of fish found at different localities are listed below :—

1. Galli Nalah near Loa at about 2,000 ft., and Taki Nalah, a large tributary of the Galli, at about 2,800 ft. April, 1938.

The specimens from the two localities got mixed up during preservation, but this is of no particular consequence as both the streams come from the same drainage basin within 3 miles of each other.

" The Loa fish live in a wider brighter stream than the Taki ones which live in deep shade in rock pools.

" The Galli Nalah falls over cataracts down from 2,000 ft. to 1,300 ft. and then makes its way gradually to the Godavari. It runs strongly throughout the year and drains a dense jungle area with practically no cultivation. The water should be rich in iron salts as it comes from the iron-ore ranges and all the rocks in the neighbourhood are markedly ferruginous ".

i.	*Danio aequipinnatus* (McClelland)	33 specimens.
ii.	*Rasbora daniconius* (Hamilton)	8 specimens.
iii.	*Garra mullya* (Sykes)	2 specimens.
iv.	*Parapsilorhynchus tentaculatus* (Annandale) ..	8 specimens.
v.	*Barbus ticto* (Hamilton)	5 specimens.
vi.	*Nemachilus dayi* Hora	16 specimens.
vii.	*Nemachilus evezardi* Day	3 specimens.
viii.	*Glyptothorax dekkanensis* (Günther) ..	4 specimens.
ix.	*Ophicephalus gachua* Hamilton	12 specimens.

2. Bailadila stream opposite the garden of the Bailadila rest-house at about 3,200 ft. April, 1938.

" The stream is here some 10 yards wide and up to 18 inches in depth. It flows below a dense canopy of bushes over a rocky bottom. It is perennial, not very fast, and not liable to very big floods. Like the Galli Nalah it drains the iron-ore ranges so that the water should be rich in iron salts.

" Several miles further down stream there is a drop of 1,000 ft. over a succession of cataracts. After that the river takes a tortuous course across the plains finally entering the Indravati."

i.	*Danio aequipinnatus* (McClelland)	7 specimens.
ii.	*Rasbora daniconius* (Hamilton)	1 specimen.
iii.	*Garra mullya* (Sykes)	1 specimen.
iv.	*Nemachilus dayi* Hora	5 specimens.
v.	*Ophicephalus gachua* Hamilton	5 specimens.

3. A strong perennial stream south of Timinar at the foot of the Bailadila ridge at about 1,700 ft. April, 1938.

"This stream varies in a short distance from a lusty brook tumbling down the mountain side by a series of rocky pools hemmed in by high jungle to a more open stream with a gravelly bed and occasional large pools.

"It joins the Indravati some miles below without having crossed any large cataracts."

i.	*Mastacembelus armatus* (Lacépède)	..	3 specimens.
ii.	*Danio aequipinnatus* (McClelland) ..	..	30 specimens.
iii.	*Rasbora daniconius* (Hamilton) ..	..	33 specimens.
iv.	*Garra mullya* (Sykes)	..	94 specimens.
v.	*Parapsilorhynchus tentaculatus* (Annandale)	..	4 specimens.
vi.	*Barbus amphibius* (Cuvier & Valenciennes)	..	4 specimens.
vii.	*Barbus pinnauratus* (Day) ..	..	1 specimen.
viii.	*Barbus ticto* (Hamilton) ..	..	9 specimens.
ix.	*Nemachilus botia* var. *aureus* Day ..	..	4 specimens.
x.	*Nemachilus dayi* Hora	..	23 specimens.
xi.	*Glyptothorax dekkanensis* (Günther).	..	6 specimens.
xii.	*Ophicephalus gachua* Hamilton ..	..	2 specimens.

In all 13 species of fish were obtained by Mr. H. Crookshank. Of these, *Mastacembelus armatus*, *Danio aequipinnatus* *Rasbora daniconius*, *Barbus ticto* and *Ophicephalus gachua* are fairly widely distributed all over India ; in fact the ranges of the first and the last extend much further towards the east. The remaining species are generally restricted to Peninsular India, but their occurrence in the Bastar State deserves special attention. *Parapsilorhynchus* has hitherto been known from the Western Ghats (Poona, Satara and Nasik Districts) and the Satpuras (Pachmarhi, C. P.). Similarly *Glyptothorax dekkanensis* was so far known from the neighbourhood of Poona. *Barbus pinnauratus*, which was known from South India only, was recently recorded from the Upper Chindwin drainage[1], and its presence, in an intermediate region, therefore, is of great zoogeographical interest. *Garra mullya*, *Nemachilus aureus* and *N. evezardi* were originally described from the environs of Poona, but have since been recorded from several localities both in the Ghats and the Satpuras ; their occurrence in the Bastar State is of special significance. Day in his *Fishes of India* recorded *Barbus amphibious* from "Central India, Deccan, Bombay and the Western coast of India, Madras and up the coast as high as Orissa," and the present record from the Bastar State falls within its known range. *Nemachilus dayi* (=*N. savona* Day *nec* Hamilton) was known to Day from "Bengal and N. W. Provinces", but has since been recorded from the Paresnath Hill and the Bombay Ghats ; it has now been found in the Central Provinces also.

Taking into consideration the fish-fauna of the Bailadila range as a whole there is clear evidence of its very close affinity to that of the Satpuras and the Western Ghats. In a recent article I[2] expressed the view that the Satpura trend, when it stretched across India from Gujrat to the Assam Himalayas, probably served as a highway for the migration

[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 336 (1937).
[2] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 255 (1937).

of the Eastern Himalayan forms to the Western Ghats. It seems probable that the Satpuras of that period comprised the hills of Chhota Nagpur, Orissa and the Central Provinces. There is considerable geological evidence to show that the lower portion of the Godavari is of great antiquity, so the Bailadila range, which just lies to the north of it, may be regarded as the southern limit of the early Satpuras in this part of India. The fish, while migrating from north-east to south-west, probably spread all over the Satpuras, and some of the earlier forms became isolated in small hill ranges of to-day, while the main wave of migration passed on to the Western Ghats and thence to the hills of Peninsular India.

According to Mr. Crookshank "Banded hematite-quartzite ridges like the Bailadila ridge extend from Chilpi Ghat in the Satpuras down into the Chanda Dist. Chanda is closely connected with N. Bastar and the hills of N. Bastar are but the continuation to the N. of the Indravati of the Bailadila ridge. Before the jungle in the Central Provinces was cut the humidity and rainfall was probably much higher than it is now and perennial streams suitable for hill fishes were probably common over all this country".

I take this opportunity to express my sincerest thanks to Mr. H. Crookshank for the great interest taken by him in the collection and preservation of fishes from a faunistically unknown part of the country.

Garra mullya (Sykes).

1921. *Garra mullya*, Hora, *Rec. Ind. Mus.* XXII, p. 658.

Garra mullya, which is the commonest species of the genus in the Indian waters, is represented by a large number of specimens in Mr. Crookshank's collection from the Bastar State. Its range extends from Kathiawar through the hills of the Central Provinces, Chhota Nagpur and Orissa to the whole of Peninsular India.

Parapsilorhynchus tentaculatus (Annandale).

1919. *Psilorhynchus tentaculatus*, Annandale, *Rec. Ind. Mus.* XVI, p. 128.
1920. ? *Psilorhynchus tentaculatus*, Hora, *Rec. Ind. Mus.* XIX, p. 210.
1921. *Parapsilorhynchus tentaculatus*, Hora, *Rec. Ind. Mus.* XXII, p. 13.
1921. *Parapsilorhynchus discophorus*, Hora, *Rec. Ind. Mus.* XXII, p. 14.
1925. *Parapsilorhynchus tentaculatus*, Hora, *Rec. Ind. Mus.* XXVII, p. 457.

Misra and I[1] recently commented on the occurrence of *Parapsilorhynchus* in the Western Ghats and the Satpuras.

In *Parapsilorhynchus* the gill-openings are restricted to the sides, just extending to the base of the pectoral fin. The specimens of *P. tentaculatus* in the collection vary from 35 mm. to 45 mm. in total length.

Barbus pinnauratus (Day).

1937. *Barbus pinnauratus*, Hora, *Rec. Ind. Mus.* XXXIX, p. 336.

Barbus pinnauratus is represented in the collection by a single specimen, 55 mm. in total length; it is partially desiccated and several

[1] Hora, S. L. & Misra K., S., *Journ. Bombay Nat. Hist. Soc.* XL, p. 34 (1938).

scales have been rubbed off. The characteristic black spots at the bases of the scales, as also the dark bands behind the opercles, are represented by series of small black dots. The lateral blotches at the sides of the tail, as also the vertical spots just below the commencement of the dorsal fin are, however, well marked. The dorsal spine, as already indicated by Day[1] for the young specimens, is weak and sparsely serrated posteriorly.

In the paper cited Hora extended the range of *B. pinnaruatus* from South India to the Upper Chindwin drainage. The occurrence of the species in the Bastar State is, therefore, of special interest.

Barbus ticto (Ham.).

1938. *Barbus ticto*, Hora & Misra, *Journ. Bombay Nat. Hist. Soc.* XL, p. 28, fig. 3.

In the specimens under report the lateral line extends over 12 to 17 scales and the number of predorsal scales varies from 9 to 10. In these respects the specimens agree with *Barbus stoliczkanus* Day, but in colouration and body proportions they are like the typical form of *B. ticto*. From the material preserved in the collection of the Indian Museum, *B. ticto* appears to be a very variable species.

Nemachilus botia var. **aureus** Day.

1878. *Nemacheilus botia* var. *aureus*, Day, *Fish. India*, p. 614, pl. clvi, fig. 4.

The specimens under report correspond to the variety *aureus*; the lateral line ceases below the dorsal fin and the dorsal fin is of much less extent than is the case in the typical *botia*. From observations made so far it seems probable that *aureus* is the common variety occurring in South India, while the typical form is found more towards the north and the east.

Nemachilus dayi Hora.

1878. *Nemacheilus savona*, Day *nec* Hamilton, *Fish. India*, p. 619, pl. clv, fig. 8.
1919. *Nemachilus savona*, Annandale *nec* Hamilton, *Rec. Ind. Mus.* XVI, p. 127.
1935. *Nemachilus dayi*, Hora, *Rec. Ind. Mus.* XXXVII, p. 57.

In 1935, I (*loc. cit.*) pointed out the precise specific limits of Hamilton's *savona* and tabulated the points in which Day's *savona* differs from it. As these differences were of sufficient specific value a new name was proposed for the latter form. According to Day, his *savona* is found in "Bengal and N. W. Provinces." It was obtained by Jenkins[2] from the Paresnath Hill and Annandale (*loc. cit.*) found it to be "common in many of the smaller rivers of Peninsular India and the Indo-Gangetic plain". He recorded it from the Yenna river at Medha.

N. dayi is represented in Mr. Crookshank's collection from all the streams investigated by him, and from the number of specimens collected it seems to be the commonest loach of the Bailadila range.

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[1] Day, F., *Fishes of India*, p. 561 (London, 1877).
[2] Jenkins, J. T., *Rec. Ind. Mus.* V, p. 128 (1910).

Nemachilus evezardi Day.

1878. *Nemacheilus Evezardi*, Day, *Fish. India*, p. 613, pl. cliii, fig. 11.
1919. *Nemachilus evezardi*, Annandale, *Rec. Ind. Mus.* XVI, p. 126, pl. i, figs. 2, 2*a*.

Nemachilus evezardi was originally described from Poona but Annandale (*loc. cit.*) found it to be the commonest species in the Bombay Ghats and also recorded it from Pachmarhi (Satpuras) in the Central Provinces. The present record of the species from the Bastar State extends its range considerably towards the east. Annandale has already directed attention to the great variation in colouration undergone by the members of this species living under different environmental conditions.

Glyptothorax dekkanensis (Günther).

1864. *Glyptosternum dekkanense*, Günther, *Cat. Fish. Brit. Mus.* V, p. 187.

Since Günther described *Glyptothorax dekkanensis* from a specimen " Three and a half inches long. From the collection of Colonel Sykes ", there has been great confusion regarding the validity of this species. Day[1] at first regarded it as a distinct species and recorded it from the Jumna river " near where it emerges from the Siwalik hills ", but later, in his *Fishes of India*, he considered it a synonym of *G. lonah* (Sykes). In my[2] revision of the Glyptosternoid fishes of India I assigned a specimen described by Annandale[3] as *Euglyptosternum saisii* from the Yenna river at Medha to *G. dekkanensis*, and later[4] another similar specimen from the Tunga river at Shimoga was referred to *G. dekkanensis*. I now find that these specimens should have been referred to *G. lonah*, as they possess a relatively longer caudal peduncle and in them the pectoral spine is provided with fine serrations on the outer side.

The specimens under report seem to represent Günther's species as they possess a relatively broad caudal peduncle and a pectoral spine which is smooth externally. In other respects also these specimens correspond more closely with *G. dekkanensis* than with *G. lonah*. To clear up the systematic position of the species, a specimen has been sent for comparison with the type in the British Museum, and on receipt of the report a full description of the species will be published.

In all the specimens under report the outer rays of the paired fins are somewhat plaited on the ventral surface. In referring a young specimen from Deolali to *G. annandalei* Hora, Misra and I[5] were greatly influenced by this character, but now I consider that the Deolali specimen belongs to *G. dekkanensis*.

Day's specimens of *G. dekkanensis* from the Jumna river probably belong to *G. conirostris* (Steind.).

Mastacembelus armatus (Lacépède), *Danio aequipinnatus* (McClelland), *Rasbora daniconius* (Hamilton), *Barbus amphibius* (Cuvier & Valenciennes) and *Ophicephalus gachua* Hamilton are well known species and do not need any further comments.

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[1] Day, F., *Proc., Zool. Soc. London*, p. 714 (1871).
[2] Hora, S. L., *Rec. Ind. Mus.* XXV, p. 24 (1923).
[3] Annandale, N., *Rec. Ind. Mus.* XVI, p. 126 (1919).
[4] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 14 (1937).
[5] Hora, S. L. & Misra, K. S., *Journ. Bombay Nat. Hist. Soc.* XL, p. 36, pl. iii, figs. 3, 3*a* (1938).

A NEW NAME FOR *SILURUS SINENSIS* HORA.

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In a recent article on a new catfish from Kwangsi, China, it was shown by me[1] that Tchang's[2] *Silurus wynaadensis* from Lunchow differs in several important features from Day's[3] *S. wynaadensis* from the Wynaad Hill, and, in consequence, the new name *S. sinensis*, was proposed for the Chinese form. Mr. Gilbert P. Whitley, in the course of a communication, very kindly directed my attention to the fact that *S. sinensis* is preoccupied by *S. sinensis* Lacépède[4]. Though Lacépède's species does not belong to the genus *Silurus*, the name has been used by several of the earlier ichthyologists[5] to denote different types of Silurid fishes. It is unfortunate that I overlooked this name when christening the new species of *Silurus* from China. I now propose the new name **Silurus gilberti** for my *S. sinensis* from Lunchow, China, thus associating it with the name of Mr. Gilbert P. Whitley, through whose kind attention I am able to rectify my error.

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[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, pp. 341-343, fig. 8 (1937).

[2] Tchang, T. L., *Bull. Fan Mem. Inst. Biol.* VII, p. 35 (1936).

[3] Day, F., *Fish. India*, p. 480, pl. cxi, fig. 6 (1877).

[4] Lacépède, B. G. E., *Hist. Nat. Poiss.* V, pp. 58, 82, pl. ii, fig. 1 (1803).

[5] McClelland, J., *Cal. Journ. Nat. Hist.* IV, p. 402 (1844); Richardson, J., *Ichth. China*, p. 281 (1845); Günther, A., *Cat. Fish. Brit. Mus.* V, p. 35 foot-note (1864); Bleeker, P., *Med. Tijdschr. Dierk.* IV, p. 125 (1873).

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A study of variations in *Barbus* (*Puntius*) *ticto* (Hamilton).

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A STUDY OF VARIATIONS IN *BARBUS* (*PUNTIUS*) *TICTO* (HAMILTON).

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CONTENTS.

INTRODUCTION.

In studying several collections of freshwater fishes from India and Burma Hora found considerable variations in the specific characters usually relied upon for the determination of Hamilton's[1] *Cyprinus* (*Puntius*) *ticto*. Though he[2] recently made an attempt to give the diagnostic features of *Barbus* (*Puntius*) *stoliczkanus* Day, a form closely allied to *B. ticto*, a collection from Dalu, in the Upper Chindwin drainage, showed that those characters were not of much use in separating the two species. Moreover, the specimens of *B. ticto* from Peninsular India[3] were found to exhibit gradations between the two forms, while Day's[4] *B. punctatus* from South India appeared to be identical with the Burmese *B. stoliczkanus*.

We may here quote from a communication received from Dr. H. M. Smith to whom a named example of *B. stoliczkanus* from Sandoway,

[1] Hamilton, F., *Fish. Ganges*, pp. 314, 389, pl. viii, fig. 87 (1822).
[2] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 330 (1937).
[3] Hora, S. L. and Misra, K. S., *Journ. Bombay Nat. Hist. Soc.* XL, p. 28 (1938); Hora, S. L., *Rec. Ind. Mus.* XL, p. 240 (1938).
[4] Day, F., *Proc. Zool. Soc. London*, p. 302 (1865).

Burma, was sent in exchange for comparison with his Siamese material. He wrote as follows :—

"The receipt of the specimen of *Puntius stoliczkanus* from Lower Burma has permitted the identification as that species of numerous examples from Northern Siam (Mepin basin) and Western Siam (Salwin basin)."

Dr. Smith's statement brought to our mind the distribution of Hamilton's *Cyprinus cosuatus* (=*Oreichthys cosuatus*)[1] and it occurred to us that in *Barbus ticto* we have probably a species which is found over a wide area, and which exhibits certain morphological variations in different types of environments encountered in its wide range of distribution. To test this hypothesis a number of characters were tabulated in a large series of specimens from different parts of India and Burma. As a result of these studies it is now definitely established that Day's *stoliczkanus* and *punctatus* cannot be regarded as distinct species, but should be merged in the synonymy of *B. ticto*. Though in the tables (*vide infra*, pp. 274-279) measurements, scale counts, etc., of only a limited number of specimens are given, the actual material examined has been very considerable. Unfortunately, it has not been possible to examine any specimen of *B. ticto* from the Punjab and Sind, but all the same the results given below seem to be fairly conclusive.

HISTORICAL.

Cyprinus (*Puntius*) *ticto* was described by Hamilton (*op. cit.*) from "the south-east parts of Bengal"; he referred to its strong resemblance with *Cyprinus* (*Puntius*) *sophore* and noted that it "wants the golden mark on the gill-covers, and seldom is found above two inches long". Among the diagnostic features of the species he directed attention to "one black spot on the lateral line above each pectoral fin, and another near the end of the tail; and with the back fin spotted, and its second ray indented behind". He further noted that "in old individuals, the dorsal, anal, and ventral fins are slightly stained with red; the dorsal is marked with two rows of dark spots". The absence of barbels was noted and the lateral line was characterised as "scarcely distinguishable".

In his account of *Cyprinus* (*Puntius*) *titius* (p. 315), a species characterised by the possession of a smooth dorsal spine, Hamilton remarked as follows :—

"In the north-east parts of Bengal I saw another fish called by the same name, and procured a drawing, now in the possession of the Bengal Government. It differed in a few particulars from the Ticto, but, the drawing being sufficient to point out the difference, I took no notes, and therefore, until I recover the drawings, I cannot give this fish a specific character, although I call it *Tictis*."

Hamilton's original drawing of the form *tictis* was reproduced by Hora,[2] and a comparison of this figure with Hamilton's figure of *ticto* brings out the following points of differences :—

i. The Dorsal fin of *tictis* is better developed and more extensive; the dorsal spine is longer than the head and very coarsely serrated internally. In *ticto* the dorsal spine is shorter than the head and finely serrated.

[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 321 (1937).
[2] Hora, S. L., *Mem. Ind. Mus.* IX, pl. xxiii, fig. 6 (1929).

ii. The anterior dark spot is much closer to the head in *tictis* than that of *ticto*. The gill-membrane and the area between operculum and preoperculum are stained with black in *ticto*, while this is not so in *tictis*. Moreover, the dorsal fin of *ticto* is marked with two rows of spots which are absent in *tictis*.

iii. The shape of the fins is somewhat different in the two forms.

iv. The body is proportionately deeper in *tictis* than in *ticto*.

The value of some of the characters tabulated above is discussed below (pp. 267-270) and it is surmised that the form *tictis* probably represents the males of *ticto*.

McClelland[1] referred Hamilton's *ticto* to his genus *Systomus* and gave the number of scales along the lateral line as 24 and " eight in depth from the base of the dorsal to the ventral on either side ". McClelland states that " A variety of this species with two rows of dots on the dorsal is figured by Buchanan as *Cyp. bimaculatus*, but as it has two black spots on each side, it should rather have been named *quadrimaculatus* ". McClelland seems to have confused the drawing of *tictis* with *ticto*, for the illustration of the latter species published by Hamilton himself shows two rows of spots on the dorsal fin. Moreover, *Cyprinus bimaculatus*, which was described by Hamilton in manuscript while stationed near Calcutta, has been shown to be *ticto* by Hora.[2]

Probably on account of the serrated nature of the dorsal spine, and the deep body, Sykes[3] referred *Cyprinus ticto* to his genus *Rohtee*, but as *ticto* is provided with a short anal fin it cannot belong to that genus. Sykes found this species in the " Mota Mola river, at Poona " and noted that the fish is provided " with from 4 to 6 black spots on the body, made up of minute dots ; one small spot above each pectoral fin, one larger one is situated on the tail, above the last anal ray, and one minute spot, sometimes wanting, near the base of the first dorsal ray ". His examples were $1\frac{1}{2}$ inches long and in them the lateral line was very obscure.

Jerdon[4] included a large number of species of South Indian Minnows in the genus *Systomus*, but it is difficult to define their precise specific limits without a fresh collection of topotypes. Regarding *ticto* he observed that " This may be an *Opsarius* ". However, he does not seem to have examined any specimen of the species. Day[5] assigned *S. tripunctatus* Jerdon to the synonymy of *ticto*. The specimens of *S. tripunctatus* were obtained by Jerdon in a small stream near the coast in Canara and are noted to possess " 2 black spots under end of dorsal, and another at base of tail ". The colouration of the species is against its having any relationship with *ticto*.

In 1865, Day[6] described a new Carp Minnow from Cochin as *Puntius punctatus* and characterized it by the possession of a serrated dorsal spine

[1] McClelland, J., *As. Res.* XIX, p. 382 (1839).
[2] Hora, S. L., *Journ. As. Soc. Bengal,* (N. S.) XXVII for 1931, p. 135 (1933).
[3] Sykes, W. H., *Trans. Zool. Soc. London,* II, p. 365 (1841).
[4] Jerdon, T. C., *Madras Journ. Lit. Sci.* XV, pp. 314-319 (1849).
[5] Day, F., *Fish. India,* p. 576 (1877).
[6] Day, F., *Proc. Zool. Soc. London,* p. 302 (1865).

and complete lateral line. He described the colouration of the species as follows :—

" Olive-green above, gradually fading into silvery on the abdomen. A black diffused spot on the twentieth and twenty-first scales of the lateral line. The anterior half of the fourth scale from the operculum, of the row next below the lateral line, deep black, and also a portion of the scale above and beneath it. Fins yellowish. Dorsal and anal tipped with orange. Dorsal spotted with black, in two longitudinal rows, with a third in the front part between the other two. The dark markings are much more visible in the months when the freshes are coming down."

The colouration of the dorsal fin is similar to that shown by Hamilton for his *Cyprinus tictis* (*vide supra*, p. 265) and, as the colours are stated to be better marked during the monsoon months, it would appear that *B. tictis* probably represents the male of *B. ticto*. As both the colouration and the extent of the lateral line are found to be variable characters in *B. ticto*, we have not found it possible to recognise *B. punctatus* as a distinct species. So far as we are aware this form has not been recorded again since Day's time. *Systomus conchonius* Jerdon[1] (*nec* Hamilton) appears to be a doubtful synonym of Day's *B. punctatus* (=*B. ticto*). It may be noted that *B. conchonius* has not yet been recorded from Peninsular India.

Günther[2] placed *ticto* in the genus *Barbus* and doubtfully assigned *Rohtee ticto* Sykes to its synonymy. He redescribed the species from 12 specimens, including 2 " Adult : not in good state. Dekkan. From Colonel Sykes' Collection ", and gave as its habitat Bengal, Assam and the Himalayas. In his description he pointed out that the osseous dorsal ray is of moderate strength and serrated, the lateral line is incomplete and the fish is provided with " A small black spot on the commencement of the lateral line, another larger one on the lateral line, immediately behind the anal fin. Upper two-thirds of the dorsal fin black ".

In 1869, Day[3] described *Barbus m'Clellandi* from Burma (Pegu and Moulmein) and noted that

" This species bears a strong resemblance to the *B. ticto*, H. B., which it appears to supersede in Eastern Burma. But it is distinguished by a complete instead of incomplete lateral line, and its body is not so compressed ; its dorsal spine and colouring also differ".

In his " Monograph of the Indian Cyprinidae ", he[4] changed the name of the species to *Barbus* (*Puntius*) *stoliczkanus* and in the description the proportion of the head to the length of the fish gave as $\frac{1}{6}$ instead of $\frac{1}{5}$. In the *Fishes of India* the species is described and figured from Eastern Burma, but it is noted that " Some Darjeeling examples agree with the Burmese fish ".

Since Day's time *B. stoliczkanus* has been recorded from Burma by Boulenger[5] (S. Shan States), Chaudhuri[6] (Putao Plains) and Hora[7] (Sandoway). In the case of the specimens from Fort Stedman, Boulenger remarked that " the anterior black spot is absent or indistinctly

[1] Jerdon, T. C., *Madras Journ. Lit. Sci.* XV, p. 317 (1849).
[2] Günther, A., *Cat. Fish. Brit. Mus.* VII, p. 153 (1868).
[3] Day, F., *Proc. Zool. Soc. London*, p. 620 (1869).
[4] Day, F., *Journ. As. Soc. Bengal*, XL, p. 328 (1871).
[5] Boulenger, G. A., *Ann. Mag. Nat. Hist.* (6) XII, p. 202 (1893).
[6] Chaudhuri, B. L., *Rec. Ind. Mus.* XVI, p. 283 (1919).
[7] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 330 (1937).

indicated". Basing his observations on young specimens from Sandoway Hora relied on the number of predorsal scales in separating *ticto* from *stoliczkanus*. He found considerable variation in the extent of the lateral line. Though Day mainly relied on the extent of the lateral line in separating the two species, he[1] refers to a specimen of *ticto* from Calcutta with the "lateral-line distinct for 6 scales, indistinct for 10 more, when it ceases"[2]. He further observed that in *B. ticto* "Cutch examples have 23 to 25 scales along the lateral-line, and one specimen had two blotches on either side of the base of the caudal fin. In Sind the dorsal spine is thin and very finely serrated. One Ganjam example had L. l.27, as had also one from Bheer Bhoom. In Orissa they had as a rule L. l.25, in the Wynaad L. l.23". Hora and Misra[3], and Hora[4] found the lateral line in *B. ticto* extending over 10 to 12 scales; they also observed well-marked sexual dimorphism with regard to colouration; the specimens with coloured dorsal and anal fins were found to be males. Just before full maturity the dorsal fin of the male becomes marked with two or more rows of black spots till finally the entire fin assumes that colour. Annandale[5] described melanic specimens of what he considered to be *B. ticto* from Rajshahi District, Bengal, and compared them with the normal paler individuals collected from the same place at the same time. We have examined these specimens and find them to belong to *B. conchonius* (Ham.); the two melanic individuals, about 81 mm. in length, are males, while the four paler individuals, about 68 to 76 mm. in length, are females.

Variation in the colouration of the Punjab examples are described by Fowler[6] as follows :—

"Variation seen in the Himalayan examples, in black at tip of dorsal, ventral and anal, absent in 2 examples. Black blotch above anal usually present and only evident in young just behind shoulder. Smaller and young from Loodianali with shoulder-spot more conspicuous, also some with 2 oblique dark bars on dorsal. The largest examples from Kalla Weddee, with the tubes of lateral line on 6 to 8 scales. Ends of dorsal and anal, and all of ventrals, jet black, also scale-edges narrowly with vertical blackish margin, even to those along edge of preventral region".

In the above account we have referred to the variations observed in *B. ticto* by the previous writers, and in the following pages we propose to give a detailed account of the variations undergone by some of the salient diagnostic features of the species.

MORPHOLOGICAL.

Dorsal spine.—It is not possible to tabulate the variations observed in the nature of the dorsal spine, which, as a rule, is moderately strong and serrated, but in some individuals, especially from the hilly areas, it is feeble and the number of teeth along its posterior border is small.

[1] Day, F., *Fish. India*, p. 577 (1877).
[2] We have examined this specimen which is now preserved in the collection of the Indian Museum.
[3] Hora, S. L. and Misra, K. S., *Journ. Bombay Nat, Hist. Soc.* XL, p. 28 (1938).
[4] Hora, S. L., *Rec. Ind. Mus.* XL, p. 240 (1938).
[5] Annandale, N., *Rec. Ind. Mus.* I, p. 81 (1907).
[6] Fowler, H. W., *Proc. Acad. Nat. Sci. Philadelphia* LXXVI, p. 86 (1924).

In this connection attention may be invited to an interesting observation made by Day[1] regarding *Barbus conchonius* (Ham.). He observed that—

> "Nainee tal specimens have the dorsal spine much less coarsely serrated than those from the plains, from whence they were introduced not many years since; they have also a darkish band along the side."

It is very difficult to assign any definite reason for the relative weakness of the spine in specimens from the hills, but it seems quite possible that in pools and puddles on the hills there is probably less competition for existence than in the case of the plain-dwelling forms, and in consequence the protective armature is more or less feebly developed. In this connection it may also be noted that in the Siluroid fishes of the plains, especially of the muddy waters, the dorsal and the pectoral spines are well developed, while the same structures are feebly developed in the hill-stream forms.

Lateral line.—With the exception of the 3 specimens from Sandoway in Lower Burma, 5 specimens from the Sittang river below Pegu, 6 specimens from Beeling near Pegu, one specimen from the Putao Plain and one specimen of *B. punctatus* from Madras, the lateral line is incomplete in all the other examples studied by us. In the majority of the specimens it ceases after 5-7 scales, but in some it extends up to the 21st scale. The extent of the lateral line very frequently varies even on two sides of the same fish. In quite a number of cases the lateral line is interrupted for a scale or two; and is usually faintly marked towards its termination.

From the information so far available it seems that the lateral line is usually complete in the Burmese examples (specimens of *B. stoliczkanus* reported so far: Day's 6 specimens from Pegu and 15 from Moulmein; Boulenger's ? specimens from S. Shan States; Chaudhuri's 1 specimen from Putao Plains and Hora's 3 specimens from Sandoway) and certain examples from South India (*Puntius punctatus* Day). In two specimens from Pagoda Twante the lateral line extends up to the 18th and the 21st scale respectively. In one specimen from Sandoway the lateral line extends over 17 scales and in another only up to the 5th scale on one side and the 7th scale on the other. In 3 specimens from Dalu, Myitkyina District (Upper Chindwin drainage), the lateral line extends up to the 7th scale and its extent sometimes varies on two sides of the same specimen.

From Dr. H. M. Smith's observations referred to above (p. 264), it seems likely that in the Siamese specimens of the species the lateral line is invariably complete.

From Assam we have examined specimens from the Naga Hills, Mangaldai, Shillong and Goalpara. The extent of the lateral line varies from the 6th to the 11th scale, and in some specimens it varies even on the two sides of the same specimen. In Bengal specimens the lateral line may extend up to 14 scales.

In the Bihar examples (Saran, Hazaribagh District and Chota Nagpur), the lateral line extends from the 6th to the 9th scale, while

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[1] Day, F., *Fish. India*, p. 576 (1877).

in 2 specimens from Orissa the lateral line is present on 8 and 10 anterior scales respectively.

In specimens from the United Provinces (Naini Tal, Bhim Tal and Dehra Dun), the lateral line extends over 6 to 10 scales. Its extent frequently varies on two sides of the same fish. In the two Peshawar examples the lateral line ceases after the 6th scale. From the Central Provinces we have examined specimens from the Narbada river (Rewa State, Ramgarh, Mandla, etc.) and the Bastar State; the lateral line is generally more extensive and may be present on 12 anterior scales.

From Peninsular India we have examined large series of specimens from a number of localities. In specimens from Deolali and Poona (Western Ghats) the lateral line is considerably more extensive and is present on 9 to 16 scales. In one specimen from Poona the lateral line is continued after 2 interruptions up to the 21st scale. In the examples from the Eastern Ghats the lateral line, as a rule, is present on 7 to 8 scales, but in certain specimens it extends, with interruptions, up to the 14th scale. In the specimens from the Coorg and the Mysore States its extent varies from 6 to 8 scales, while, according to Deraniyagala[1], in the Ceylon specimens the lateral line may extend up to the 15th scale, though in a few specimens examined by us it was found to be present only on 7 scales.

Judging from the variations noted above in the extent of the lateral line it seems that this character is undergoing retrogression and that it cannot be employed for the separation of varieties or races. Though, as a rule, the lateral line is complete in the Burmese examples, a number of individuals have been found in which the lateral line is very short. Further, specimens with extended or complete lateral line have also been found in South India.

Number of Predorsal Scales.—Hora[2] attached great importance to the number of predorsal scale in separating the Burmese species *stoliczkanus* from the Indian form *ticto*, but a detailed study of the character has shown that specimens from India show considerable variation in this respect. The Burmese examples, however, do not exhibit much variation in the number of predorsal scales as in 14 out of 16 specimens the number of predorsal scales is 9, while in the remaining 2 specimens, one from Sandoway and one from Beeling, it is only 8. In specimens from India, the number varies from 9 to 12, though the common number is 11. The specimens from Shimoga and Coorg, however, form an exception as the usual number of predorsal scales in them is 9 or 10. According to Deraniyagala (*op. cit.*), there are only 8 or 9 predorsal scales in the Ceylonese examples. In this respect the South Indian and Ceylonese specimens show a distinct affinity to specimens from Burma.

Length of head.—In his *Fishes of India* Day gives the proportion of the length of the head to the total length as $\frac{1}{5}$ in *B. ticto* and $\frac{1}{6}$ in *B. stoliczkanus*. In the original description of the latter species, however, he[3] gave it as $\frac{1}{5}$ and not $\frac{1}{6}$. Similar discrepancies are to be found in Day's

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[1] Deraniyagala, P. E. P., *Ceylon Journ. Sci.* (B) XVI, p. 21 (1930).
[2] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 330 (1937).
[3] Day, F., *Proc. Zool. Soc. London*, p. 619 (1869); *vide* description of *Barbus mcClellandi.*

earlier and later descriptions of *Barbus* (*Puntius*) *punctatus*. In the specimens that we have examined the length of head is contained from 3·1 to 4·1 times in the length without the caudal, but in a majority of the specimens the proportion varies from 3·3 to 3·6. The length of the head varies considerably with the length or age of the specimens; it is proportionately longer in smaller individuals than in the larger ones. In this respect we have not found much difference between the Burmese and Indian examples. Attention may, however, be directed to the fact that according to Deraniyagala the length of the head of the Ceylon examples is contained from 3 to 3·25 times in the standard length.

Depth of body.—The form of the body of a fish varies considerably according to whether it lives in swift currents, slow streams or stagnant waters (*vide* Hora[1]). *Barbus ticto* is found in sluggish waters and pools of both hills and plains and the form of its body is, therefore, subject to considerable variation. In the specimens that we have examined it is contained from 2·3 to 3·0 times in the standard length, but in a majority of the individuals the proportion varies from 2·4 to 2·6. The specimens collected from clear waters of hill-streams are, as a rule, narrower and more graceful.

Colouration.—The colouration in fishes varies according to the age, sex and habitat of a fish and the variations in colour that we have noticed in the case of specimens of *B. ticto* from different localities can be readily explained. We have referred above (p. 267) to the melanic colouration of the males during the breeding season; the extent of this secondary sexual feature is different in different individuals at various seasons of the year. A black mark at the commencement of the dorsal fin is present only in very young specimens, usually below one inch in length. It fades away in older individuals. The two characteristic lateral spots of the species are fairly well marked in young specimens up to about 1½ to 2 inches in length, but with growth the anterior spot gradually disappears. The anterior spot, when present, extends over 3rd and 4th scales of the lateral line. In some individuals it is somewhat oblong so that when its upper portion fades away, it is represented by a spot below the lateral line. The position of the posterior spot is somewhat variable, probably in accordance with the number of scales in the lateral line. As a rule it covers 2 to 3 scales (16th to 18th) but may extend over a few more of the posterior scales. Sometimes it is only present on the 18th and 19th scales and in very rare cases it extends to the 20th scale. In some large individuals the posterior spot may be faintly marked or totally absent.

As in the case of other freshwater fishes, the Burmese examples are, as a rule, more brilliantly coloured, and in this respect the South Indian specimens from Coorg and Shimoga show greater affinity to the Burmese than to the Indian examples.

GEOGRAPHICAL DISTRIBUTION.

Judging from the variations undergone by the characters discussed above, it seems that *Barbus ticto* is a very variable species and

[1] Hora, S. L., *Journ. As. Soc. Bengal,* Science I, pp. 1-7 (1935).

that *Cyprinus tictis* Ham., *Puntius punctatus* Day and *P. stoliczkanus* Day should be included in its synonymy. Its range of distribution is here extended from India to Burma and Siam. From the records of freshwater fishes so far available it seems that *B. ticto* is perhaps not so common in Burma and Siam, as it is in India. Though the Burmese examples are, as a rule, characterised by the possession of a complete lateral line and 8 to 9 predorsal scales, these features cannot be regarded as specific owing to the wide range of variations undergone by examples from India by these characters.

We have referred above to the similarity between examples of *B. ticto* from Burma and South India, especially with regard to the extent of the lateral line, number of predorsal scales and colouration. In this connection it is of particular interest to establish the identity of *B. stoliczkanus* Day with *B. punctatus* Day. We give below measurements, scale counts, position of colour spots, etc., in a specimen of the latter species and when these are compared with similar measurements, etc., of Burmese examples on page 274 it will be noticed that there is practically no difference between the two sets of specimens. The occurrence of the same form of *B. ticto* in Burma and Peninsular India lends further support to the view expressed by one[1] of us in recent years that the freshwater fish-fauna of India is derived from the eastern countries and that in the distribution of hill-stream forms the once extensive Satpura trend of mountain chains played a very important part.

Measurements in millimetres, scale counts, and position of colour spots of a specimen of Barbus (Puntius) punctatus *Day.*

Standard length	48·5
Depth of body	18·5
Length of head	12·5
Length of snout	2·0
Diameter of eye	4·5
Interorbitial distance	5·3
No. of scales along lateral line	26
No. of perforated scales	26
No. of predorsal scales	9
No. of scales between L. l. and base of pelvic fin	3½
Position of anterior black spot	3
Position of posterior black spot	20–21

BARBUS (*PUNTIUS*) *TICTO* (HAM.) AND ALLIED SPECIES.

Both in literature and in the large named collection in the Indian Museum we have found great confusion regarding the precise specific limits that have been assigned to *Barbus ticto* and to several other closely allied forms. Day[2] included 11 species in his group of *Barbus* characterised by the total absence of barbels and by the possession of an osseous and serrated dorsal ray. These are, (i) *Barbus apogon* (Kuhl) C. and V. ; (ii) *B. ambassis* Day ; (iii) *B. conchonius* (Ham.) ; (iv) *B. ticto* (Ham.) ; (v) *B. stoliczkanus* Day ; (vi) *B. punctatus* Day ; (vii) *B. gelius* (Ham.) ;

[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 255 (1937).
[2] Day, F., *Fish. India*, pp. 575-579 (1877).

(viii) *B. phutunio* (Ham.) ; (ix) *B. cumingii* Günther ; (x) *B. nigrofasciatus* Günther ; and (xi) *B. gugunio* (Ham.). Of these, the first two possess more than 35 scales along the lateral line and can thus be readily distinguished from the remaining species in which the number of lateral line scales is below 30. *B. gugunio* is so insufficiently characterised that it is not possible to define its precise specific limits. *B. stoliczkanus* and *B. punctatus* have been shown above to be synonyms of *B. ticto.* The remaining six species, among which considerable confusion prevails, can be distinguished with the help of the table on page 273.

From a study of the table it would seem probable that this group of species may have evolved from a common parental stock and that the present-day differences between them in the form of the body, the number of scales, the extent of the lateral line and colouration are the result of some kind of habitudinal segregation or isolation of the various forms. As detailed data regarding the bionomics of the different species are not available, it is not possible for us at this stage to say much about the probable ancestory of these species.

SUMMARY.

Attention is directed to the great range of variations exhibited by Hamilton's *Cyprinus* (*Puntius*) *ticto* in the nature of its dorsal spine, the extent of its lateral line, the number of predorsal scales, proportions and colouration. These characters, which have been tabulated in a large series of specimens from different parts of India and Burma, show gradations between different types hitherto regarded as distinct species. It is thus shown that Day's *Barbus punctatus* from Peninsular India and *B. stoliczkanus* from Burma cannot be regarded as distinct species but should be treated as synonyms of *B. ticto.* In the historical review comments are made on the various forms that have been found to be identical with *B. ticto.* In discussing the geographical range of the species special attention is directed to the fact that the Burmese and Siamese examples (*stoliczkanus*-type) show greater affinity to specimens from Southern India (*punctatus*-type). At the end a table of comparison between *B. ticto* and five other allied species is given and it is surmised that they may have evolved from a common parental stock along slightly divergent lines.

TABLE I.—*BARBUS (PUNTIUS) TICTO* (HAM.) AND ALLIED SPECIES.

Barbus ticto (Ham.).	*Barbus conchonius* (Ham.).	*Barbus gelius* (Ham.).	*Barbus phutunio* (Ham.).	*Barbus comingii* (Günth.).	*Barbus nigrofasciatus* (Günth.).
1. Height of body 3 to $3\frac{1}{2}$ in total length.	Height of body $2\frac{2}{3}$ in total length.	Height of body 3 to $3\frac{1}{2}$ in total length.	Height of body 3 to $3\frac{1}{4}$ in total length.	Height of body 3 in total length.	Height of body $2\frac{2}{3}$ in total length.
2. L.l. 22-26; complete or incomplete.	L.l. 24-28; incomplete, extending up to 18 scales.	L.l. 23-24; incomplete extending up to 5 or 6 scales.	L.l. 20-23; incomplete extending up to 3 or 4 scales.	L.l. 21; incomplete extending up to 4 scales.	L.l. 20-21; complete.
3. An anterior spot on 3rd or 4th scale (frequently absent). Posterior spot ranges between 16th to 20th scales.	Anterior spot absent posterior spot ranges between 17th to 20th scales.	A black band over tail somewhat anterior to base of caudal fin; another less distinct band behind base of that fin. A black spot passes across base of the anterior half of dorsal extending one-third the distance up the rays. A black band over the base of the anal which is highest in front.	A black band passing from the back to opposite the middle of pectoral fin; a second from the back to the posterior end of the base of anal, two other lighter bands pass downwards one from the anterior the other from the posterior extremity of dorsal. A black band down the centre of dorsal, another at base of caudal. In adults the pectoral band decreases in size whilst that on the dorsal fin breaks up into spots.	In colouration more or less similar to *B. phutunio* two dark vertical bands one descending to the pectoral, the second across the free portion of the tail.	A black band passing from eye to eye: body with 3 vertical bands, the first from the back to middle of pectoral fin; the second from base of dorsal to behind base of ventral, and the third across free portion of tail; dorsal, anterior portion of pelvics and outer edge of anal black.
4. Throughout India, Ceylon, Burma and Siam.	Assam, Lower Bengal, Orissa, Behar, N. W. F. Province, Punjab and Deccan (?).	Ganjam, Orissa, Bengal and Assam.	Ganjam, Orissa and through Bengal to Burma.	Ceylon	Southern Ceylon.

TABLE II.—*BARBUS* (*PUNTIUS*) *TICTO* (HAM.) FROM BURMA.

Measurements in millimetres, scale counts and position of colour spots.

	Beeling, East of Pegu.				Sittang river below Pegu.				Tanja, N. E. Burma.	Sandoway.				Pagoda Twante.		Dalu, Upper Chindwin.		
Standard length	29·0	32·0	36·0	33·0	34·0	32·2	29·0	32·5	37·0	31·0	28·0	31·0	32·0	22·0	23·0	30·0	33·0	31·0
Depth of body	12·5	13·5	15·5	13·8	13·5	12·0	11·5	12·5	16·0	11·5	10·5	12·2	13·0	9·0	9·5	11·3	12·5	11·0
Length of head	7·5	8·0	10·0	8·0	9·5	9·0	9·0	9·0	10·5	8·0	7·3	8·0	8·0	6·0	7·0	8·5	9·0	9·0
Length of snout	1·5	2·0	2·0	1·5	2·0	2·0	1·8	2·0	2·0	2·0	2·0	2·0	2·5	1·5	2·0	2·0	2·0	2·0
Diameter of eye	3·5	3·5	4·0	3·5	4·0	3·5	3·5	3·5	4·0	2·6	2·6	2·5	3·0	2·7	3·0	3·5	3·5	3·5
Interorbital distance	3·4	3·0	4·0	3·0	4·0	3·4	3·5	3·4	4·0	3·8	3·8	3·5	4·0	2·7	3·0	4·0	4·0	4·0
No. of scales along lateral line	24	25	25	25	25	24	24	24	22	22	23	23	24	22	23	23	24	23
No. of perforated scales	24	25	25	25	24	24	24	24	22	22	23	7	24	18	21	6	7	7
No. of predorsal scales	9	9	9	10	9	9	8	9	9	9	9	8	9	9	9	9	9	9
Position of anterior black spot	3	3	3	3	4	3	3	4	..	4	3	4	4	3	4	abs.	abs.	abs.
Position of posterior black spot	18·19	18·19			18	18	18	18	..	17	17	17	18	17	18	20	20	20

TABLE III.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM ASSAM.

Measurements in millimetres, scale counts and position of colour spots.

	Naga Hills.					Mangaldai, Garo Hills.			Shillong.				Goalpara.	
Standard length	29·0	24·0	23·5	29·0	20·0	34·0	33·0	26·0	43·0	42·5	27·0	30·0	26·0	22·0
Depth of body	10·0	9·0	9·0	10·0	7·8	14·0	14·0	10·0	15·0	16·0	10·0	10·0	10·0	8·0
Length of head	8·5	7·5	7·5	8·0	6·0	9·0	9·0	8·0	12·0	13·0	7·5	8·6	8·0	7·0
Length of snout	2·5	2·0	2·0	2·5	2·0	3·0	3·0	2·8	3·5	3·5	2·5	2·7	2·5	2·0
Diameter of eye	3·2	3·0	3·0	3·2	2·5	4·0	4·0	3·5	4·0	4·0	3·0	3·0	3·0	2·5
Interorbital distance	3·2	3·0	3·0	3·2	2·5	4·0	4·0	3·0	4·5	4·5	3·5	3·5	3·2	2·8
No. of scales along lateral line	22	22	23	22	23	23	23	23	22	22	22	22	26	27
No. of perforated scales	6	6	6	7	7	8	8	6	6	7	6	7	9	6
No. of predorsal scales	9	9	9	9	9	11	11	10	10	10	11	10	11	11
Position of anterior black spot	4	4	4	4	4	4	4	4	abs.	abs.	abs.	abs.	abs.	abs.
Position of posterior black spot	18	18	18	18	18	18	18	18	16	16	18	17	abs.	abs.

TABLE IV.—*BARBUS* (*PUNTIUS*) *TICTO* (HAM.) FROM BENGAL, BIHAR AND ORISSA.

Measurements in millimetres, scale counts and position of colour spots.

	BENGAL.									BIHAR.								ORISSA.	
	Darjeeling.			Ranigunge.						Hazaribagh.			Saran District.				Chota-Nagpur.	Orissa.	Puri.
Standard length	39·0	36·5	33·0	50·0	44·0	49·0	43·5	37·0	34·0	38·0	38·0	40·0	37·0	38·0	31·0	33·0	26·0	36·5	32·0
Depth of body	16·0	15·0	14·0	21·0	18·0	21·0	18·0	15·0	13·5	15·0	14·0	17·0	16·0	15·0	12·0	14·0	10·0	14·0	13·0
Length of head	11·5	10·5	9·7	13·0	12·5	13·0	12·0	11·0	9·5	11·0	11·0	11·0	10·5	10·5	9·5	9·0	8·0	10·0	9·0
Length of snout	3·0	3·0	2·1	3·2	3·0	3·1	3·0	2·5	2·5	2·9	2·8	3·0	2·9	3·0	2·7	2·8	2·5	3·2	3·0
Diameter of eye	4·0	4·2	4·0	5·5	5·0	5·3	4·8	4·5	3·5	4·0	4·0	4·0	4·0	4·0	3·4	3·5	3·0	4·0	4·0
Interorbital distance	4·2	4·2	4·0	5·5	5·3	5·4	5·0	4·5	3·5	4·5	4·3	4·4	4·0	4·0	3·4	3·5	3·2	4·0	4·0
No. of scales along lateral lines ..	25	26	23	25	25	24	24	22	22	23	23	24	26	25	24	25	24	25	25
No. of perforated scales. ..	12	6	12	13	14	9	9	7	6	7	8	7	8	8	7	9	6	10	8
No. of predorsal scales ..	11	10	10	11	10	10	10	9	9	11	11	11	11	11	9	11	9	10	11
Position of anterior black spot ..	4	3	4	abs.	abs.	abs.	abs.	abs.	abs.	3	4	abs.	4	3	abs.	4	abs.	4	3
Position of posterior black spot ..	19	18	18	abs.	abs.	abs.	abs.	abs.	abs.	17	17	18	19	18	18	18	18	19	17

TABLE V.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM UNITED PROVINCES, N.-W. F. PROVINCE AND CENTRAL PROVINCES.

Measurements in millimetres, scale counts and position of colour spots.

	UNITED PROVINCES.					N.-W. F. PROVINCE.		CENTRAL PROVINCES.								
	Naini Tal.	Dehra Dun.	Bhim Tal.			Peshawar.		Mandla.		Bastar State.				Rewa State.		
Standard length	29·5	41·5	44·0	43·0	40·0	33·0	36·5	24·0	26·0	41·0	51·0	56·0	35·0	49·0	41·5	39·0
Depth of body	11·5	16·5	18·0	16·5	16·5	14·0	14·5	9·0	10·0	15·0	21·0	22·0	14·0	18·5	16·5	15·0
Length of head	8·5	11·2	12·7	12·0	12·0	9·5	10·5	7·5	8·0	10·0	13·0	14·0	10·0	13·5	10·5	10·0
Length of snout	2·5	3·0	4·0	2·9	3·0	2·5	2·5	2·0	2·5	2·5	3·5	4·0	2·6	3·5	3·3	3·1
Diameter of eye	3·6	4·5	4·5	4·3	4·0	3·5	4·0	3·0	3·0	4·2	5·0	5·2	4·1	4·0	4·0	4·0
Interorbital distance	3·8	5·C	5·0	5·0	5·0	3·5	4·5	3·0	3·2	4·5	5·3	6·0	4·5	4·2	4·1	4·0
No. of scales along lateral line	26	23	23	24	23	24	25	23	23	23	22	23	24	22	22	22
No. of perforated scales	8	9	10	6	8	6	6	8	9	9	11	10	12	7	7	7
No. of predorsal scales	11	10	11	11	11	10	11	10	9	9	8	10	9	10	9	10
Position of anterior black spot	abs.	abs.	abs.	abs.	abs.	4	abs.	abs.	abs.	3	4	3	3	4	4	4
Position of posterior black spot	19	17	17	18	17	17	19	18	18	17	17	18	17	17	17	19

TABLE VI.—*BARBUS* (*PUNTIUS*) *TICTO* (HAM.) FROM EASTERN AND WESTERN GHATS.

Measurements in millimetres, scale counts and position of colour spots.

	Eastern Ghats.							Western Ghats.							
	Cuddapah District, Ganjam river near Kodur.			Nallamalai Hills 800 ft. Mahanadi river.				Deolali.				Poona.			
Standard length	32·0	37·0	33·0	42·0	34·0	32·0	48·5	46·0	41·0	39·0	31·5	52·0	45·0	46·0	51·0
Depth of body	13·0	14·5	13·5	16·0	14·0	13·0	20·0	18·0	16·5	15·0	12·0	21·0	17·5	19·0	20·0
Length of head	9·0	10·0	9·0	12·0	9·5	9·0	13·0	12·5	12·0	11·5	9·0	13·5	13·0	13·0	14·0
Length of snout	2·6	3·0	2·9	3·2	3·0	2·9	3·4	4·0	3·5	3·0	2·8	3·5	3·3	3·3	3·5
Diameter of eye	4·0	4·0	4·0	4·5	4·0	4·0	4·5	5·0	4·0	3·8	3·4	4·5	4·5	4·6	4·5
Interorbital distance..	4·0	4·0	4·0	4·8	4·0	4·0	4·5	5·5	4·2	4·0	3·5	4·5	4·5	4·6	4·7
No. of scales along lateral line	24	23	24	25	24	24	25	23	25	26	25	23	25	24	25
No. of perforated scales	10	7	7	7	14	7	14	13	11	15	9	10	13	9	16
No. of predorsal scales	11	11	10	10	10	11	11	11	11	10	9	9	10	10	10
Position of anterior black spot	4	4	4	4	4	4	abs.	abs.	abs.	abs.	abs.	..	4	4	4
Position of posterior black spot	19	18	18	19	18	19	19	17	17	19	18	18	19	18	18

TABLE VII.—*BARBUS (PUNTIUS) TICTO* (HAM.) FROM SOUTH INDIA AND CEYLON.

Measurements in millimetres, scale counts and position of colour spots.

	South India.				Ceylon.	
	Shimoga.			Coorg State.		
Standard length ..	30·0	26·0	21·0	27·5	35·0	22·5
Depth of body ..	11·5	10·0	8·0	10·0	13·0	8·5
Length of head ..	9·0	8·0	6·5	8·0	10·5	7·0
Length of snout ..	2·0	2·0	1·9	2·0	2·0	1·5
Diameter of eye ..	4·0	3·0	2·5	3·0	3·8	2·6
Interorbital distance ..	4·0	3·0	2·5	3·0	3·8	2·6
No. of scales along lateral line.	23	23	23	23	22	22
No. of perforated scales ..	8	6	6	7	7	7
No. of predorsal scales ..	9	9	10	10	9	10
Position of anterior black spot.	4	4	4	4	3	4
Position of posterior black spot.	18	17	17	17	17	18

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Siluroid Fishes of India, Burma and Ceylon.
IX. Fishes of the genera *Gagata* Bleeker and *Nangra* Day.
X. Fishes of the genus *Batasio* Blyth.

By
SUNDER LAL HORA
and
NIRMAL CHANDRA LAW

CALCUTTA
MARCH,

SILUROID FISHES OF INDIA, BURMA AND CEYLON.

By Sunder Lal Hora, *D.Sc.*, *F.R.S.E*, *F.N.I.*, *Assistant Superintendent, Zoological Survey of India*, and Nirmal Chandra Law, *M.Sc.*

(Plates I and II.)

IX. Fishes of the genera *Gagata* Bleeker and *Nangra* Day.

Recently while working out collections of freshwater fishes from Assam and Travancore, considerable difficulty was experienced in separating Indian species hitherto referred to the genera *Gagata* Bleeker, *Batasio* Blyth and *Nangra* Day. This led us to examine the entire material of these genera in the extensive collections of the Indian Museum with very interesting results. In this article we propose to deal with the fishes of the genus *Gagata*, of which *Nangra* is regarded as a synonym, while the genus *Batasio* is treated in detail in the next article of this series.

Gagata Bleeker.

1858. *Gagata*, Bleeker, *Ichthyol, Archipel, Ind. Prodromus*, I, p. 204 (orthotype *G. typus* Blkr. = *Pimelodus gagata* Ham.).
1860. *Gagata*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 152.
1863. *Gagata*, Bleeker, *Ned. Tijdschr. Dierk.* I, p. 90.
1864. *Callomystax*, Günther, *Cat. Fish. Brit. Mus.* V, p. 218.
1877. *Gagata*, Day, *Fish, India*, p. 492.
1877. *Nangra*, Day, *ibid.*, p. 493.
1911. *Gagata*, Regan, *Ann. Mag. Nat. Hist.* (8) VIII, p. 564.
1911. *Nangra*, Regan, *ibid.* (8) VIII, p. 564.
1913. *Gagata*, Weber & de Beaufort, *Fish. Indo-Austral. Archipel.* II, p. 268.

In 1858, Bleeker provisionally proposed the generic name *Gagata* and included a number of heterogenous forms in it. It was not until 1863, however, that its definition was given and *Pimelodus gagata* Hamilton, rechristened as *Gagata typus* Bleeker, definitely assigned to it. As Bleeker had not seen any specimen of Hamilton's species, his characterisation of the genus was imperfect and the systematic position he assigned to it was faulty. However, Blyth recognised *Gagata* as a valid genus, but remarked : " This, as it now stands, is a heterogeneous assemblage of species, and I know of none that can properly range with the type of it, which is *Pimelodus gagata*, B. H. : a species with the maxillary cirri bony towards the base, as in *Bagarius* to a much greater extent. The *Menoda* dubiously referred to this type by Dr. Bleeker is identical with *Bagrus corsula*, Val., which therefore must stand as *B. menoda* (B. H.) ; the *Mangois* appertaining to my genus *Amblyceps* ; and another type may be here indicated as—*Hara*, nobis, n.g." Günther redescribed the species *gagata* from 5 examples, which he regarded as " Types of the species. Presented by G. R. Waterhouse, Esqr.," and erected for it a new genus *Callomystax*. He was aware of Bleeker's *Gagata* but did not consider it a valid genus and remarked :

> " Dr. V. Bleeker does not appear to have been acquainted with this fish, so that not only the characters of the genus which he proposed for it are incorrect, but it is also improperly referred to the ' phalanx ' of *Arii*, and to the ' Stirps ' of *Bagrini*."

Later workers, however, regarded *Gagata* Bleeker as a valid genus and considered Günther's *Callomystax* as its synonym. Günther had assigned only one species to this genus, but Day included 4 species in it—*G. cenia* (Ham.) with *G. gagata* (Ham.) as a synonym, *G. itchkeea* (Sykes), *G. batasio* (Ham.) and *G. tengana* (Ham.). According to Day, the range of the genus extends from the "Rivers of Sind, India (except Madras) and Burma." One more species—*G. schmidti*—has since been described by Volz[1] from Sumatra.

Day established another genus *Nangra* to accommodate *Pimelodus nangra* Hamilton, *P. viridescens* Hamilton and a new species from the Sone River (*Nangra punctata*) and remarked :—

> "This genus differs from *Gagata* in its barbels not being placed in a transverse line behind the chin : and in its gill-membranes not being confluent with a broad isthmus but rather deeply notched. It is allied in some respects to *Macrones*, but has no teeth on the palate, whilst its air-vessel is enclosed in bone."

Our studies have shown that the characters distinguishing the two genera intergrade into each other and can at best be used for separating species in the same genus.

In order to discuss the systematic position of the above-mentioned species, it is necessary to know, in the first instance, the precise limits of the genus *Gagata* Hamilton. Though quite a number of Hamilton's species are inadequately characterised, there is no difficulty in recognising *P. gagata*, as its detailed description and figure leave no doubt about its identity. Reference may here be made to a few of its most salient features as given by Hamilton.

i. There are eight barbles ; the two nasal and the four mandibulary barbels are shorter than the head, while the maxillary barbels are rather longer, and have a membrane extending half way along their hinder edge.
ii. The anal fin is provided with 17 rays.
iii. The fins are edged with black.
iv. The bones of the head are roughened with variously intersecting ridges.
v. The jaws are crowded with minute teeth, while the tongue and the palate are smooth.
vi. Both apertures of each nostril are circular and are separated only by the nasal barbel.

Bleeker (1863, p. 90) based his genus *Gagata* on the following characters :—

> "Cirri 8, nasales 2, supramaxillares 2, inframaxillares 4. Palatum edentulum. Dentes maxillis pluriseriati parvi. Scutum capitis granosum, fonticulis lateralibus. Cirri supramaxillares basi membrana muniti. Spina dorsi edentula. B. 5."

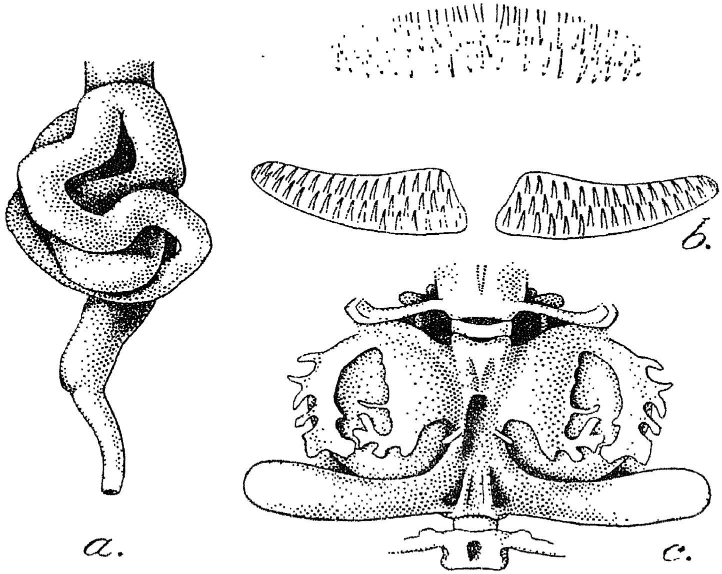
Günther gave a good definition of the genus under *Callomystax* and included the following additional important diagnostic characters in it :—

i. The two pairs of mandibulary barbels are inserted in a transverse series immediately behind the margin of the lower lip. The maxillary barbels are osseous to some extent.
ii. The eyes are without free orbital margins.

[1] Volz, W., *Revue Suisse de Zool.* XII, p. 470 (1904).

iii. The gill-openings are of moderate width, the gill-membranes being confluent with the skin of the isthmus.

Day added to the generic definition the character of the air-bladder which he found to consist of "two rounded portions, each of which is enclosed in an osseous cup." Regan in his synopsis of the genera of the Sisoridae defined the main skeletal features of *Gagata* and *Nangra*.



Text-fig. 1.—Alimentary canal, dentition and air-bladder of *Gagata gagata* (Hamilton).
a. Alimentary canal. $\times 2\frac{4}{5}$; *b.* Dentition. $\times 8$; *c.* Air-bladder. $\times 3\frac{3}{5}$.

In view of what is stated above, the genus *Gagata* may be defined as follows :—

Gagata comprises a group of Sisorid fishes in which the body is compressed and the snub-nosed head, though globular, is somewhat elevated, only rarely depressed. The upper surface of the head is provided with sharp, longitudinal ridges ; it is covered with thin, smooth skin, but some of the bones on the dorsal surface are variously roughened. The median fontanel is very conspicuous. The mouth is small, transverse and ventral. The lips are thick, continuous and somewhat fimbriated ; the post-labial grooves are restricted round the corners of the mouth. The jaws are provided with small, villiform teeth ; the palate is edentulous. There are eight barbels ; the nasal barbels are small and thin and are prolongations of the broad flaps separating the two nostrils on each side ; these flaps, when present, cover a part of the posterior nostrils on each side ; the maxillary barbels are osseous proximally, and are provided with membraneous flaps along the inner surface ; the two pairs of mandibular barbels are shorter and may or may not be situated in a more or less transverse series behind the posterior lip.

The skin in the thoracic region is smooth. The nostrils are close together. The eyes are subcutaneous. The gill-openings are fairly wide; the gill-membranes may be confluent with the skin of the isthmus, or deeply notched. The rayed dorsal fin is provided with a strong spine. The adipose dorsal is short but prominent. The pectorals are provided with strong spines which are denticulated internally. The pelvics are horizontal and 6-rayed; they are situated behind the dorsal. The anal fin is short. The caudal fin is deeply forked. The air-bladder is divided into two rounded portions which are partially enclosed in bone and come in direct contact with the skin above the pectorals. There are 5 to 7 branchiostegal rays.

Regan distinguished *Gagata* from the other genera of the Sisoridae by the following combination of characters :—

> " Praecaudal vertebrae normal, with the ribs attached to the simple parapophysis and the neural arches without the lateral processes; end of transverse process of fifth vertebra appearing as a rugose plate behind the lateral cutaneous area.
>
> " Head somewhat compressed and elevated; tail and caudal vertebrae normal.
> " Mesopterygoid smaller than metapterygoid, pelvis behind the dorsal.
> " Gill-membranes attached to isthmus."

Further, he distinguished *Nangra* from *Gagata* by the fact that in the former the gill-membranes are free from the isthmus.

Having defined the generic limits of *Gagata* and *Nangra* we may now consider the systematic position of the various species assigned to these genera. Hamilton's *Pimelodus cenia* is undoubtedly congeneric with his *P. gagata*. In the former the author seems to have overlooked the minute nasal barbels. Günther appears to have overlooked this species entirely, for there is no mention of it in his *Catalogue*. Though in 1869, Day[1] recognised it as a distinct species, in his *Fishes of India* and the *Fauna* he considered it as a young form of *Gagata gagata*. We have examined a large series of specimens of both the species in the collection of the Indian Museum and are definitely of the opinion that they are quite distinct and represent two valid species of the genus *Gagata*.

Day (*loc. cit.*, 1877, p. 493) included Hamilton's *Pimelodus batasio*[2] in the genus *Gagata*, and as he had no specimen for study he seems to have been greatly influenced by Hamilton's statement to the effect that " There is no *slit* under the throat........ " Cuvier and Valenciennes[3] included this species under *Bagrus*, Blyth[4] under *Batasio* and Günther[5] under *Macrones*. We have examined several specimens of the species from the type-locality and find that Hamilton's statement with regard to a slit under the throat is not correct. In Hamilton's original drawing[6] of the species the two nostrils of each side are shown as situated wide apart, which precludes its being a member of the Sisoridae. This species has been rightly assigned by Shaw and Sheb-

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[1] Day, F., *Proc. Zool. Soc. London*, p. 309 (1869).
[2] Hamilton, F., *Fish. Ganges*, p. 179 (Edinburgh: 1822).
[3] Cuvier, G. and Valenciennes, A., *Hist. Nat. Poisson* XIV, p. 425 (1839).
[4] Blyth, E., *Journ., As. Soc. Bengal* XXIX, p. 150 (1860).
[5] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 83 (1864).
[6] Day, F., *Fish. India*, pl. xcix, fig. 5 (1877); Hora, S. L., *Mem. Ind. Mus.* IX, pl. xxii, fig. 3 (1929).

beare[1] to the genus *Batasio* Blyth, which is dealt with in the next article of this series.

As regards the true systematic position of *Pimelodus tengana* Hamilton there is some difficulty. It has been included under the genus *Bagrus* by Cuvier and Valenciennes, *Batasio* by Blyth, *Macrones* by Günther and *Gagata* by Day. This species was collected by Hamilton in the Brahmaputra and in his original notes the description is dated "Gualpara, 29th July, 1808." To elucidate its systematic position attention may be directed to the following salient features as noted by Hamilton :—

1. There are eight barbels shorter than the head.
2. The anal fin possesses fourteen rays.
3. It is a small fish of about 3 inches in length.
4. The back is marked with many black dots, which are collected into a spot above each pectoral fin, and also on the crown of the head. The fins of the back and tail are also dotted, so that the edge of the last is black, and several spots are formed on the first.
5. Both openings of each nostril are circular, with a tendril between them.
6. Under the lower jaw there is no slit.

Though it is stated by Hamilton that the two openings of each nostril have a barbel between them, his figure shows that these openings are situated widely apart and that the posterior one is provided with a barbel at the anterior end. It would thus appear that the species cannot be referred to the Sisoridae, but belongs to the Bagridae. It seems to belong to the genus *Batasio* and is conspecific with Blyth's *B. affinis*. We shall elucidate further the systematic position of this species in our account of the fishes of the genus *Batasio*.

Hamilton's *P. nangra*, the type of Day's genus *Nangra*, differs from *Gagata gagata* and *G. cenia* in having longer barbels and deeply notched gill-membranes, though Hamilton in the description of this species also states "There is no *slit* under the throat." The bases of the mandibular barbels are not situated in a straight line. As indicated above, we do not regard these differences of generic value, especially as *Gagata itchkeea* (Sykes) is a form intermediate in characters between *Gagata* and *Nangra*.

In *Pimelodus viridescens*, Hamilton mentioned only six barbels; evidently he overlooked the minute nasal barbels. The most significant feature of this species is its greatly depressed head and anterior part of body. It is stated to possess a slit under the throat. From a careful study of Day's descriptions of *Nangra punctata* and *Nangra viridescens* and also from an examination of his drawings of the two species it seems probable that the two are identical, the latter being the juvenile form of the former. Two fresh specimens in our collection also confirm this view. In the nature of its gill-openings, *G. viridescens* agrees with *G. nangra*. Day recorded this species from Poona and one of us[2] also recorded it from the Deccan. Re-examination of the

[1] Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, p. 97, fig. 98 (1938).

[2] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 19 (1937).

material has shown that the Deccan specimens are referrable to *G. itchkeea* in which the isthmus is very narrow and the mandibular barbels are not situated in an absolute straight line.

The only extra-Indian species of *Gagata* is *G. schmidti* Volz from Sumatra. Its salient features are the depressed head, 1½ times broader than high; the small eyes, longitudinal diameter being contained 13 times in length of head; the absence of fontanels; the dorsal spine being dentated along the front and hind borders; the very narrow isthmus, and its almost uniform gray brown colour.

The Indian species of the genus *Gagata* may be distinguished by the following key:—

Key to the Indian species of the genus Gagata *Bleeker*.

I. Nasal barbels small or rudimentary, being almost as long as or considerably shorter than longitudinal diameter of eye.
- A. Dorsal fin considerably longer than head; both dorsals, anal, pectoral and pelvic fins black distally.
  [Gill-membranes united with a fairly broad isthmus; maxillary barbels slightly and mandibular barbels considerably shorter than head; bases of mandibular barbels close together and in a transverse row; median groove on head extending to end of occipital process] .. .. *G. gagata.*
- B. Dorsal fin considerably shorter than head; distal portions of fins not coloured black.
  1. Maxillary barbels longer than head. [Gill-membranes united with a very narrow isthmus; mandibular barbels somewhat shorter than head; bases of inner mandibular barbels somewhat in advance of those of the outer; median groove on head extending as far as posterior border of orbit and followed by a small, median, oval fontanel] .. *G. itchkeea.*
  2. Maxillary barbels considerably shorter than head.
     - *a.* Bases of mandibular barbels close together and in a transverse row. [Gill-membranes united with a narrow isthmus; width of head considerably less than its length in front of pectorals; median groove on head extending to base of occipital process] .. *G. cenia.*
     - *b.* Bases of mandibular barbels set widely apart, and at different levels. [Gill-membranes united with each other and the isthmus; head almost as broad as its length in front of pectorals; median groove on head extending to base of occipital process] .. *G. viridescens.*

II. Nasal barbels almost as long or longer than head. [Bases of mandibular barbels set widely apart, and at different levels; gill-membranes united with each other across the isthmus; maxillary and outer mandibular barbels much longer than head; median groove on head extending to base of occipital process] .. .. *G. nangra.*

Gagata gagata (Hamilton).

Plate I, figs. 1, 2.

1822. *Pimelodus gagata*, Hamilton, *Fish. Ganges*, pp. 197, 379, pl. xxxix, fig. 65.
1854. *Pimelodus gagata*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.
1858. *Gagata gagata*, Bleeker, *Ichthyol. Archipel. Indici, Prodromus*, I, *Siluri*, p. 206.
1860. *Gagata gagata*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 151.
1862. *Gagata typus*, Bleeker, *Atl. Ichthyol.* II, p. 7.
1864. *Callomystax gagata*, Günther, *Cat. Fish. Brit. Mus.* V, p. 218.
1869. *Gagata typus*, Day, *Proc. Zool. Soc. London*, p. 309.
1877. *Gagata cenia*, Day (in part), *Fish. India*, p. 492, pl. cxv, fig. 4.
1877. *Callomystax gagata*, Beavan, *Freshw. Fish. India*, p. 149.
1889. *Gagata cenia*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 208, fig. 75.

D. 1/6; A. 3-4/10-12; P. 1/9; V. 1/5; C. 19.

Gagata gagata is a medium-sized, stoutly-built species in which the dorsal profile rises moderately to the commencement of the dorsal fin beyond which it slopes down gradually to the base of the caudal fin. The ventral profile is almost horizontal as far as the commencement of the pelvic fins and thereafter it rises gradually to the base of the caudal fin. The fish is compressed from side to side, more so in the posterior half; the dorsal surface forms a narrow ridge. The ventral surface in front of the pelvic fin is somewhat flattened.

The head is broadly pointed in front; its length is contained from 3·61 to 3·93 times in the standard length. The height of the head at the occiput is contained from 1·05 to 1·45 times and its width from 1·25 to 1·57 times in its length. The snout is prominent and globular; it is produced in front of the mouth for a short distance. The eyes are dorso-lateral in position and are situated nearer to the posterior margin of the operculum than to the tip of the snout. The diameter of the eye is contained from 2·65 to 3·76 times in the length of the head, from 0·89 to 1·58 times in the length of the snout and from 0·65 to 1·20 times in the inter-orbital width. The two nostrils of each side are fairly prominent, close together and situated much nearer to the tip of the snout than to the eye. The dorsal surface of the head is covered with smooth skin but is marked with bony ridges. The median groove on the head commences from in front of the nostrils and is continued with slight variations to the end of the occipital process which misses the basal bone of the dorsal fin by a short distance. The occipital process is long and narrow, almost 4 to 5 times as long as broad at its base. The mouth is small and horizontal; it is bordered by thick and slightly fimbriated lips which are continuous at the angles of the mouth. There are patches of small, villiform teeth in the jaws. There are four pairs of barbels; the nasal barbels are small and thin and are rarely as long as the longitudinal diameter of eye. The maxillary barbels possess

stiff bony bases and membranous flaps along the inner side of the proximal one-third of their lengths. These barbels rarely exceed the length of the head. The two pairs of mandibular barbels have somewhat swollen bases which are arranged in a transverse row behind the lower lip; these barbels are shorter than half the length of the maxillary barbels. The gill-opening is restricted on the ventral surface; the distance between the two openings is contained from 0·55 to 0·92 times in the diameter of the eye.

The depth of the body is contained from 3·34 to 4·37 times in the standard length. The caudal peduncle is well formed; its least height is contained from 1·28 to 2·00 times in its length. Two oval patches of skin above the pectorals indicate the areas where the air-bladder comes directly in contact with the skin. The cubito-humeral processes are fairly well marked. The anal opening is situated nearer to the commencement of the caudal fin than to that of the pectorals. The urino-genital openings[1] are separate; in the female they are situated immediately behind the anus and form a slit-like aperture bordered by fleshy lips which project in the form of a short papilla-like structure distally. In the male the urinary opening is situated on a papilla behind the anus.

The dorsal fin is pointed and situated almost wholly in advance of the pelvic fins; it is longer than the head; its spine is long, pointed and almost as long as, slightly shorter or longer than the head. It is finely serrated along the distal one-third of the anterior border. The adipose fin is short, but well marked; its base is somewhat longer than that of the rayed dorsal. The pectoral fins are also pointed and are placed only slightly above the ventral surface; they do not extend to the base of the pelvic fins. The pectoral spine is strong and denticulated internally; its outer border is provided with a few teeth at the distal end. The pelvic fins extend considerably beyond the anal opening and their outer rays are pointed. The anal fin is of moderate length and the caudal fin is deeply forked with both the lobes pointed, the upper lobe is somewhat better developed than the lower.

The general colour of the body is opaque yellow verging to dull gray. The greater part of the pectorals, the distal halves of the dorsal, pelvic, and anal fins are conspicuously coloured black. The caudal fin is whitish. The colouration of the species is one of its most characteristic features.

Distribution.—Unfortunately a number of specimens of *Gagata gagata* in the collection of the Indian Museum do not bear locality labels, but it seems probable that the species is found in the Ganges, Brahmaputra and Irrawadi River systems. It is represented in the collection from Allahabad, Calcutta, Khulna and Prome. It is said to attain a foot in length.

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[1] Urino-genital structures similar to those described here are erroneously termed by Mookerjee, Mazumdar and Das Gupta as "vagina" and "penis" (*Ind. Journ. Vet. Sci. Animal Husb.* X, p. 295, 1940). The authors seem to have ignored the fact that in teleosts the "urinary opening may be separate or confluent with that of the genital ducts and is frequently placed on a more or less prominent papilla (*papilla urogenitalis*). If separate, the urinary opening is behind the genital; and if a papilla is developed, its extremity is perforated by the urethra, the genital opening being situated near the base" (Günther, *Introduction to the Study of Fishes*, p. 156, 1880).

Measurements in millimetres of the specimens of *Gagata gagata* (Ham.)

—	Allahabad.	Hooghli R., Bengal.				Pusar R., Khulna, Bengal.	Prome, Burma.	Locality unknown.						
Standard length	102·0	77·0	79·0	94·0	97·5	83·5	118·0	81·5	90·0	90·5	92·0	120·0	139·0	143·0
Length of head	26·0	20·0	20·5	24·5	26·0	22·0	30·5	21·5	23·5	23·0	23·5	32·0	38·5	38·0
Height of head at occiput ..	20·5	16·0	19·5	21·0	20·5	17·0	21·0	16·5	19·0	19·5	17·0	26·0	27·5	28·5
Width of head	18·5	15·5	13·0	19·5	18·5	17·5	19·5	17·0	16·5	17·5	16·0	23·0	25·0	25·0
Length of snout	10·0	8·0	8·5	9·5	10·5	8·5	12·5	8·5	10·0	10·0	9·5	13·5	13·0	16·0
Diameter of eye	8·5	6·5	5·0	8·0	8·0	7·0	10·5	7·5	7·0	7·5	6·5	8·5	14·5	12·0
Interorbital width ..	8·0	7·0	6·0	7·5	9·0	8·0	8·0	6·5	8·0	7·0	7·0	9·5	9·5	9·5
Depth of body	28·5	23·0	21·0	26·0	26·5	22·5	27·0	21·5	26·5	25·5	24·5	33·0	36·0	33·5
Length of caudal peduncle ..	17·0	9·0	11·0	14·0	13·0	13·0	18·5	10·5	12·0	13·0	13·5	16·0	21·5	23·0
Least height of caudal peduncle.	8·5	7·0	7·5	7·5	8·5	7·5	11·0	7·0	8·0	8·0	8·5	11·0	13·0	11.5
Longest ray of dorsal ..	33·5	25·0	23·5	31·5	37·5	27·5	29·0	28·0	30·0	35·0	34·5	40·5	42·0	38·5
Length of dorsal spine ..	27·5	20·0	19·0	27·0	29·0	23·0	25·0	23·5	24·0	29·0	25·0	33·5	35·5	D.
Length of pectoral ..	28·5	22·0	21·5	28·0	29·5	22·0	30·5	22·0	14·0	27·0	28·0	32·5	43·5	42·0
Length of pectoral spine ..	25·5	19·0	19·0	24·5	26·5	21·5	28·0	21·0	22·0	25·0	24·5	30·5	39·0	37·0
Length of ventral ..	18·0	13·0	13·5	18·0	18·5	15·5	18·0	14·0	14·5	17·5	15·5	21·0	26·5	25·5
Longest ray of anal ..	21·0	D.	12·0	18·5	19·0	D.	18·5	15·0	17·0	21·0	17·0	D.	30·0	D.
Length of base of anal ..	16·0	11·0	11·0	13·5	13·5	11·5	17·0	12·0	14·0	15·0	14·5	17·5	19·5	20·0
Length of base of adipose dorsal.	16·5	11·5	10·5	14·5	13·0	8·5	15·0	12·5	10·5	10·0	14·0	14·0	16·5	16·0

Gagata itchkeea (Sykes).

Plate I, figs. 3, 4.

1840. *Phractocephalus itchkeea*, Sykes, *Trans. Zool. Soc. London* II, p. 373, pl. lxvii, fig. 1.
1849. *Pimelodus itchkeea*, Jerdon, *Madras Journ. Litt. Sci.* XV, p. 341.
1854. *Bagrus itchkeea*, Bleeker, *Verh. Bat. Gen.* XXV, p. 56.
1864. *Macrones itchkeea*, *Cat. Fish. Brit. Mus.* V, p. 84.
1876. *Hemipimelodus itchkeea*, Day, *Journ. Linn. Soc. London, Zoology* XII, p. 571.
1877. *Gagata itchkeea*, Day, *Fish. India*, p. 492, pl. cxv, fig. 6.
1889. *Gagata itchkeea*, Day, *Faun. Brit. Ind., Fish* I, p. 209.
1937. *Nangra viridescens*, Hora (*nec* Hamilton), *Rec. Ind. Mus.* XXXIX, p. 19.
1937. *Nangra viridescens*, Hora & Misra (*nec* Hamilton), *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 511 ; *ibid.* XL, p. 23, 1938.

D. 2/6 ; A. 2-3/9-10 ; P. 1/8 ; V. 1/5 ; C. 18-19.

Gagata itchkeea is a small, almost cylinderical fish in which both the dorsal and the ventral profiles are slightly arched. The body is only slightly compressed anteriorly, but in the region behind the pelvic fins the compression is more marked. The ventral surface in front of the pelvic fins is only slightly flattened and, in consequence, the pectoral fins are placed at a considerably higher level than the ventral surface.

The head is short, globular and rounded anteriorly ; its length is contained from 3·57 to 4·05 times in the standard length. The height of the head at the occiput is contained from 1·25 to 1·50 times and its width from 1·16 to 1·50 times in its length. The snout is so much rounded that one gets the impression of a pug-headed fish and the nostrils are almost directed anteriorly ; it projects beyond the mouth for a short distance. The eyes are large and dorso-lateral in position ; they are not visible from the ventral surface. The diameter of the eye is contained from 2·20 to 2·75 times in the length of the head, from 0·60 to 1·00 times in the length of the snout and from 0·63 to 0·87 times in the interorbital distance. The nostrils are large and well formed and are situated almost midway between the tip of the snout and the eyes. The median groove on the head extends from between the nostrils to the base of the occipital process, but anteriorly there are lodged in it one large and one small fontanels. After the second fontanel the groove is very shallow and hardly perceptible posteriorly. The edges of the groove are slightly raised to form longitudinal ridges. The occipital process is long and narrow, its length is about 3 times its width at the base ; it is separated from the basal bone of the dorsal fin by a short distance. The mouth is small, inferior and horizontal ; it is bordered by fleshy lips which are continuous and free at the angles of the mouth. The teeth are small, villiform, and hardly perceptible. There are four pairs of barbels ; the nasal barbels are small and considerably shorter than the diameter of the eye ; the maxillary barbels are longer than the head and their basal parts stiff ; the membrane in

their axils is little developed; the two pairs of mandibular barbels are almost equal and are as long as the head behind the anterior border of the orbit. The bases of the mandibular barbels are not situated exactly in a transverse line behind the lower lip, but those of the inner pair are slightly in advance of those of the outer. The gill-membranes are attached to the isthmus but the gill-openings are separated by a distance which is generally less than one-fifth of the diameter of the eye.

The depth of the body is contained from 4·00 to 5·41 times in the standard length. The least height of the caudal peduncle is contained from 1·14 to 1·85 times in its length. The portion of the body where the air-bladder comes in close contact with the skin is not well marked externally, but the cubito-humeral processes are fairly distinct. The anus is followed by a small urino-genital papilla.

The dorsal fin is situated in advance of the pelvic fins; it is generally shorter than the head. The dorsal spine is a strong prickle which is smooth along both the borders. The adipose dorsal is small, but well developed. The pectoral fin is pointed and almost reaches the base of the pelvic fins; its spine is strong and crenulated along the outer border but serrated for two-thirds of its length internally. The pelvic fins extend beyond the anal opening, but are separated from the anal fin by a short distance. The anal fin is short like the dorsal. The caudal fin is deeply forked; both the lobes are pointed, the upper being somewhat longer.

Sykes noted that the colour of the fish is "yellowish glossy silver, inclining to greenish on the back, and silvery on the belly; marked with dark bluish brown broad spots along the back, head, and at the base of the rays of the tail". Day remarked that the colour is "yellowish-bronze, becoming silvery on the sides and abdomen: some dark blotches along the back descending to half way down the sides. A black blotch on either lobe of the caudal, and another on the dorsal fin". In the specimens examined by us the colour varies only slightly from the earlier descriptions, and the saddle-shaped black bands on the body though only faintly marked in some are fairly conspicuous in others.

Distribution.—As stated by Day, *G. itchkeea* is found only in the rivers of the Deccan. In the collection of the Indian Museum, this species is represented from Deolali, Poona, Satara (Bombay Presidency) and from the Cauvery in the Coorg State.

Remarks.—*G. itchkeea* is intermediate between *G. gagata* and *G. nangra* in several respects and on account of its wide gill-openings and the disposition of the bases of the mandibular barbels is liable to be referred to the genus *Nangra*. Its relatively longer barbels also show its affinity to *G. nangra*. Sykes considered it a close ally of Hamilton's *Pimelodus tengana,* which we have referred to the genus *Batasio* Blyth. *G. itchkeea* rarely exceeds three inches in length and seems to be very common in the waterways at Poona.

Measurements in millimetres of the specimens of *Gagata itchkeea* (Sykes).

—	Deolali.	Poona.					Satara.		Coorg.	Bombay market.	Meema.
Standard length	38·0	38·5	40·5	42·5	46·0	46·5	47·0	49·0	50·0	41·0	40·0
Length of head	10·0	10·5	10·0	11·0	12·5	11·5	13·0	13·0	14·0	11·0	10·5
Height of head at occiput	7·0	7·0	8·0	7·5	8·5	9·0	9·0	9·5	10·5	7·5	7·5
Width of head	7·0	7·0	8·0	8·0	8·5	9·5	9·0	10·5	12·0	9·0	7·5
Length of snout	3·5	3·5	3·0	4·0	4·0	3·0	4·5	5·0	4·0	4·0	3·5
Diameter of eye	4·5	4·5	4·5	4·0	5·5	5·0	5·0	5·0	6·0	5·0	4·5
Interorbital width	3·0	3·0	3·0	3·5	3·5	3·5	3·5	4·0	4·0	3·5	3·0
Depth of body	8·0	9·5	9·0	10·0	8·5	11·0	11·5	11·0	12·5	9·0	8·0
Length of caudal peduncle	4·0	5·5	6·5	7·0	5·0	7·0	7·0	7·5	8·5	5·0	4·0
Least height of caudal peduncle	3·0	3·5	3·5	4·0	4·0	4·0	4·5	5·0	5·0	4·0	3·5
Longest ray of dorsal	8·5	9·0	9·0	11·0	11·0	10·5	11·8	12·0	13·0	10·5	10·5
Length of dorsal spine	6·0	7·5	8·0	9·0	9·0	8·5	9·8	10·4	9·5	8·0	8·0
Length of pectoral	11·0	11·0	10·5	12·0	12·0	12·5	14·0	13·5	15·5	13·0	13·0
Length of pectoral spine	9·0	8·0	9·5	10·0	10·5	11·5	12·5	12·0	14·0	11·0	11·5
Length of ventral	7·0	6·0	6·5	8·0	7·5	7·0	8·0	8·5	9·5	7·5	6·5
Longest ray of anal	8·0	7·5	8·0	7·0	8·5	9·0	10·0	10·5	11·5	8·0	D.
Length of base of anal	6·5	5·5	6·5	6·8	5·5	6·0	7·0	8·5	8·0	6·5	6·0
Length of base of adipose dorsal	8·0	5·0	5·5	6·5	5·0	6·0	7·0	7·0	7·5	5·5	6·0
Width of isthmus	0·5	0·9	1·0	0·8	1·0	0·95	1·0	1·0	0·3	0·9	1·5

Gagata cenia (Hamilton).

Plate I, figs. 5, 6.

1822. *Pimelodus cenia*, Hamilton, *Fish. Ganges*, pp. 174, 376, pl. xxxi, fig. 57.
1854. *Pimelodus cenia*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.
1869. *Hemipimelodus cenia*, Day, *Proc. Zool. Soc. London*, p. 308.
1871. *Hemipimelodus cenia*, Day, *Proc. Zool. Soc. London*, p. 288.
1877. *Gagata cenia*, Day (in part), *Fish. India*, p. 492, pl. cxv, fig. 5.
1889. *Gagata cenia*, Day (in part), *Faun. Brit. Ind.* Fish. I, p. 208.
1890. *Gagata cenia*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Geneva* (2) IX, p. 121.
1921. *Gagata cenia*, Hora, *Rec. Ind. Mus.* XXII, p. 182.
1938. *Gagata cenia*, Hora, *Rec. Ind. Mus.* XL, p. 180, fig. 6.
1939. *Gagata cenia*, Das, *Rec. Ind. Mus.* XLI, p. 448.

D. 2/6; A. 2-3/10-12; P. 1/7-9; V. 1/5; C. 17-19.

Gagata cenia is a comparatively small and slender fish, in which the dorsal and the ventral profiles are slightly arched. The body, however, becomes considerably narrow in the caudal region. The ventral surface in front of the pelvic fins is flattened and horizontal. The dorsal surface is somewhat rounded and the head and the body, except in the tail region, are moderately compressed.

The head is flattened on the ventral surface and more or less rounded anteriorly; its length is contained from 3·62 to 4·47 times in the standard length. The height of the head at the occiput is contained from 1·29 to 1·87 times, and its width from 1·40 to 2·00 times in its length. The snout is prominent, globular and projects beyond the mouth for a considerable distance. The eyes are large and dorso-lateral in position; they are not visible from the ventral surface. They are situated either in the middle of the head or slightly nearer to the posterior margin of the operculum than to the tip of the snout. The diameter of the eye is contained from 1·87 to 3·41 times in the length of the head, from 0·62 to 1·33 times in the length of the snout and from 0·50 to 0·85 times in the interorbital width. The nostrils are situated almost midway between the eye and the tip of the snout or slightly nearer to the former than to the latter. The head is covered with smooth skin, but its dorsal surface is marked with two longitudinal bony ridges and the supra-orbital bones are also slightly raised above the surface. The median groove on the head commences from in front of the nostrils and after a slight interruption is continued to a point in front of the base of the occipital process. The occipital process is about three times as long as broad at its base and misses the basal bone of the dorsal fin by a short distance. The mouth is small, horizontal and crescentic; it is bordered by fleshy lips which are free and continuous at the angles of the mouth. The median portion of the upper lip is swollen and plicated; it forms a prominent fold in front of the mouth. There are small and villiform teeth in the jaws. There are four pairs of barbels; the nasal barbels are so minute that they are likely to be overlooked; the basal portions of the maxillary barbels are stiff and there is a thick membrane in their axils; they are slightly shorter than the head; the mandibular barbels are considerably shorter and their bases are situated in a transverse series behind the lower lip. In a very large number of

specimens there are two finger-like processes situated in the mid-ventral line between the bases of the inner mandibular barbels. Sometimes these structures are represented by nodules attached to the posterior lips, while in certain specimens they are entirely absent. These structures, like the barbels, are probably tactile in function. The gill-openings are somewhat restricted on the ventral surface by a narrow isthmus; the distance between the gill-openings is contained from 0·15 to 0·63 times in the diameter of the eye.

The depth of the body is contained from 4·0 to 6·0 times in the standard length. The least height of the caudal peduncle is contained from 1·27 to 2·14 times in its length. The portion of the body where the air-bladder comes in contact with the skin is not well marked externally and the cubito-humeral processes are not so prominent. The urino-genital openings are similar to those described above for *Gagata gagata* (*vide supra*, p. 16).

The dorsal fin is obliquely truncate and its base is situated wholly in advance of the pelvic fins; it is usually shorter than the head, but in rare cases it may be just as long as the head. The dorsal spine is a short, strong prickle which is smooth along the posterior border but is finely serrated along the anterior border, especially along the distal portion. The adipose dorsal is short but well marked. Generally the pectoral fin is shorter than the head, but sometimes it is equal to or even slightly longer than the head; they are separated from the pelvic fins by a considerable distance. The pectoral spine is denticulated in the middle along its inner border and serrated along the distal half of the outer border. The pelvic fins reach as far as or extend slightly beyond the anal opening. The anal fin is short and low. The caudal fin is deeply forked and both the lobes are sharply pointed; the upper lobe is somewhat longer than the lower.

Hamilton noted that "The general *colour* is silver, with some dusky on the back, and the bars descending to the lateral lines. The end of the tail is black; and the first fin of the back, and that of the tail, are stained with the same colour. The eyes are silver-coloured." He had also noted that the back was marked with four transverse bars. Day, who regarded this species as comprising of young individuals only, stated that "The *young* are of a yellowish bronze colour, becoming silvery on the abdomen: they have three dark bands over the head and four more over the back, descending as low as the lateral-line. Caudal with a semi-lunar black band, or a black blotch on each lobe: a dark mark across the dorsal fin." The specimens in the collection of the Indian Museum vary slightly as regards colouration but in general agree closely with Day's description.

Distribution.—Hamilton described this species from the northern parts of Bengal, but as Day had confused *Gagata gagata* with *G. cenia*, it is not possible to accept the range of distribution of this species given by him. In the collection of the Indian Museum, it is represented from the Punjab, Delhi, Nepal, Bihar, Orissa, Bengal, and Assam (including Chindwin Drainage System). It rarely exceeds six inches in length and was originally described by Hamilton from specimens about three inches in length.

Measurements in millimetres of specimens of *Gagata cenia* (Ham.).

	Manipur, Assam.					Chutri Gouri in Terai, Nepal.		Calcutta and Nawabgunge, Bengal.			Barhat and Damodar River, Bihar.			Orissa.	Delhi.		Chenab Canal, Punjab.
Standard length ..	56·5	59·5	65·0	72·5	84·5	59·0	77·0	63·5	38·0	42·5	59·0	63·0	42·0	55·0	66·0	78·5	52·0
Length of head	14·0	15·0	15·5	18·0	23·0	16·2	20·5	17·5	8·5	11·0	16·0	17·0	11·5	15·0	18·2	21·5	14·0
Height of head at occiput .	10·0	10·0	12·0	11·5	13·5	10·0	12·5	10·0	5·5	6·0	8·5	9·5	6·5	8·5	11·0	12·0	7·5
Width of head	8·5	9·0	11·0	10·5	13·0	9·0	11·5	9·2	5·5	6·0	8·5	9·0	6·0	7·5	9·2	11·2	8·0
Length of snout	5·5	5·0	5·5	7·0	8·0	5·5	8·0	6·0	3·0	3·5	6·0	7·0	4·5	5·0	7·2	8·0	6·0
Diameter of eye	6·5	8·0	7·0	7·5	7·0	5·5	6·0	5·5	3·5	4·0	5·5	7·0	4·0	6·0	6·5	7·0	5·0
Interorbital width ..	4·0	4·0	4·0	5·5	6·0	4·0	5·0	4·0	2·5	2·0	3·5	4·0	2·8	3·5	3·5	5·0	3·0
Depth of body	11·0	12·0	14·0	14·0	17·0	10·0	13·0	12·0	6·5	8·5	10·5	10·5	10·5	9·5	11·4	13·5	10·0
Length of caudal peduncle ..	8·0	8·5	9·0	8·5	10·0	8·0	11·0	7·5	5·0	6·0	8·0	7·0	7·0	7·5	9·0	10·0	6·5
Least height of caudal peduncle	5·0	5·0	6·0	6·5	7·0	5·0	5·5	5·0	3·5	4·5	4·5	5·5	4·0	3·5	5·5	6·5	3·5
Longest ray of dorsal ..	12·5	14·0	15·0	14·5	22·5	14·0	17·0	13·0	8·5	11·0	13·0	13·5	10·5	11·5	13·5	16·0	11·0
Length of dorsal spine ..	11·0	11·0	12·0	D.	15·5	11·0	15·0	12·0	7·5	9·5	11·5	12·0	9·5	9·5	13·0	14·5	10·0
Length of pectoral ..	15·0	15·0	16·0	D.	20·5	13·0	18·0	13·0	8·5	12·5	12·0	14·5	10·0	11·5	15·5	17·5	11·5
Length of pectoral spine ..	12·0	13·5	14·0	D.	18·0	11·5	17·5	12·5	8·0	10·0	13·0	14·0	9·5	11·0	14·0	17·0	10·5
ength of ventral ..	8·5	10·0	11·0	12·5	14·0	9·0	11·0	9·5	6·0	7·0	12·5	9·5	6·0	7·5	10·5	12·0	7·5
Longest ray of anal ..	10·5	10·5	12·0	14·0	14·5	9·5	10·5	9·5	9·0	8·5	10·0	10·0	7·0	7·0	11·0	12·0	8·0
Length of base of anal ..	9·0	9·0	11·0	11·5	13·0	8·5	11·0	8·5	9·5	9·0	9·0	9·5	6·0	8·5	9·0	9·5	8·5
Length of base of adipose dorsal.	9·0	8·5	8·5	12·0	10·5	8·0	10·0	6·5	4·5	6·0	7·0	8·5	6·5	6·5	8·5	10·5	8·0
Width of isthmus ..	1·0	1·2	D.	1·0	3·0	3·5	3·5	3·0	0·8	1·0	1·0	2·5	1·5	3·0	2·5	3·0	2·0

Gagata viridescens (Hamilton).

Plate I, figs. 7, 8.

* 1822. *Pimelodus viridescens*, Hamilton, *Fish. Ganges*, pp. 173, 376, pl. x, fig. 56.
1854. *Pimelodus viridescens*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.
1877. *Nangra punctata*, Day, *Fish, India*, p. 494, pl. cxv, fig. 8.
1877. *Nangra viridescens*, Day, *Fish. India*, p. 494, pl. cxv, fig. 7.
1889. *Nangra punctata*, Day, *Faun. Brit. Ind. Fish.* I, p. 212. fig. 76.
1889. *Nangra viridescens*, Day, *Faun. Brit. Ind. Fish.* I, p. 212.

D. 1/6; A. 2/9; P. 1/8; V. 1/5; C. 21.

In *Gagata virridescens* the head and the body in front of the anal fin is greatly depressed and the ventral surface is flattened. The tail is somewhat compressed and subcylindrical. The dorsal profile is slightly arched, while the ventral profile is straight and horizontal in front of the anal fin.

The head is large and broad, it is covered with minute spine-like structures; its length is contained from 3·00 to 3·18 times in the standard length. The height of the head is contained from 1·63 to 1·78 times and its width from 1·27 to 1·31 times in its length. The snout is broad and rounded in front; it projects beyond the mouth for a considerable distance. The eyes are of moderate size and dorso-lateral in position; they are not visible from the ventral surface. The eyes are relatively larger in young specimens and are situated almost in the middle of the length of the head; their diameter is contained from 3·50 to 4·16 times in the length of the head and from 1·37 to 1·75 times in the length of the snout. The interorbital distance is equal to the diameter of the eye. The nostrils are well-formed, rounded apertures; they are situated much nearer to the tip of the snout than to the eyes. The median groove on the head is pointed both anteriorly and posteriorly, and extends from in front of the nostrils to the base of the occipital process; behind the level of the eyes there is a slight ridge across the groove. The occipital process is long and club-shaped; its width at the base is contained about 4 times in its length; it misses the basal bone of the dorsal fin by a short distance. The mouth is wide, inferior and horizontal; it is provided with fleshy lips which are continuous at the angles of the mouth. The anterior lip is papillated, and both the lips at the angles of the mouth are plicated. The posterior lip is also somewhat roughened along its middle part. The teeth are small and villiform; they are arranged in bands in the jaws. There are four pairs of barbels; the nasals are minute or rudimentary and are liable to be overlooked altogether; the maxillary barbels are considerably shorter than the head, are provided with stiff basal portions which lie in lateral grooves; the mandibular barbels are much shorter and their bases are situated wide apart, those of the inner pair are considerably in advance of those of the outer pair. The gill-openings are wide and extensive; the gill-membranes are confluent with each other and with the isthmus in the mid-ventral line. The width of the isthmus is very narrow.

The depth of the body is contained from 4·45 to 4·54 times in the standard length. The least height of the caudal peduncle is contained

from 1·63 to 1·71 times in its length. The portion of the body where the air-bladder comes directly in contact with the skin is not well marked externally. The cubito-humeral processes are well developed. The external urino-genital organs are similar to those described in *G. gagata* (*vide supra*, p. 16).

The dorsal fin is short and low, and is situated wholly in front of the pelvics; it is considerably shorter than the head and is provided with a small, strong spine, which is smooth along both the borders. The adipose dorsal is short, but well marked; the length of its base is almost equal to that of the rayed dorsal. The paired fins are horizontally placed; the pectorals are shorter than the head and provided with a very strong spine which is smooth along the outer border, but is strongly denticulated internally. The pectorals are separated from the ventrals by a considerable distance. The pelvics are small and pointed and extend beyond the anal opening. The caudal fin is deeply forked, with both the lobes pointed and subequal.

Hamilton stated that in his *Pimelodus viridescens* "The sides are silver *coloured*, the belly livid, and the fins of the back and tail spotted." The back is noted to be "reddish-brown, crossed by three green bars; and with opaque spotless sides". Day described the colouration of his *Nangra punctata* as follows: "coppery, glossed with gold on the sides: a black blotch on occiput, and three or four along the back descending half way down the sides. A black band on dorsal, and some black markings on the caudal." In his *N. viridescens*, which seems to represent young specimens, the colour is "glossy greenish-brown on the back, with two very light green bands passing one from the base of either dorsal fin to the middle of the depth of the body. A dark band on the dorsal fin and spots on either lobe of the caudal". In a young specimen, 44·5 mm. in standard length, besides the two short bands mentioned by Day, there are two other, one obliquely passing through the posterior part of the head and another on the back in front of the base of the caudal fin. The colouration of the larger specimen corresponds fairly closely with that of Day's *N. punctata*.

Distribution.—Hamilton described this species from the rivers of the northern parts of Bengal, but Day noted "Rivers of Northern Bengal, not uncommon in the Jumna at Delhi, and also found at Poona in the Deccan". The two specimens we have referred to *G. viridescens* are from Bengal and Assam respectively and we doubt whether the range of this species extends to the Deccan.

Measurements in millimetres.

	Tezpur, Assam.	Barakar, Santal Parganas.
Standard length	75·0	44·5
Length of head	25·0	14·0
Height of head at occiput	14·0	8·5
Width of head	19·0	11·0
Length of snout	10·5	5·5
Diameter of eye	6·0	4·0
Interorbital width	6·0	4·0
Depth of body	16·5	10·0
Length of caudal peduncle	9·0	6·0

Measurements in millimetres.

	Tezpur, Assam.	', Santal Parganas.
Least height of caudal peduncle		
Longest ray of dorsal .	15·5	8·0
Length of dorsal spine .	9·5	6·5
Length of pectoral .. .	18·0	12·5
Length of pectoral spine .	16·0	11·0
Length of ventral .. .	12·0	7·0
Longest ray of anal .. .	14·5	8·5
Length of base of anal .	9·0	6·5
Length of base of adipose dorsal	9·5	6·5

Gagata nangra (Hamilton).

Plate I, figs. 9, 10.

1822. *Pimelodus nangra*, Hamilton, *Fish. Ganges*, pp. 193, 378, pl. xi, fig. 63.
1854. *Pimelodus nangra*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.
1871. *Macrones nangra*, Day, *Proc. Zool. Soc. London*, p. 288.
1877. *Nangra buchanani*, Day, *Fish. India*, p. 494, pl. cxiii, fig. 3.
1889. *Nangra buchanani*, Day, *Faun. Brit. Ind. Fish.* I, p. 211.

D. 2/9-10 ; A. 3/10 ; P. 1/9 ; V. 1/5 ; C. 16-17.

Gagata nangra is a small and slender species in which the dorsal profile is slightly arched, while the ventral profile is horizontal in front of the pelvic fins and thence rises gradually to the tail. The body is compressed from side to side, more so in the tail region. The ventral surface of the head and the anterior part of the body are flattened.

The head is sharp, long and oval; its length is contained from 3·83 to 4·18 times in the standard length. The height of the head is contained 2·0 times and its width from 1·06 to 1·50 times in its length. The snout is long and pointed, and projects in front of the mouth for a considerable distance. The eyes are relatively small and dorso-lateral in position; they are not visible from the ventral surface. The diameter of the eye is contained from 5·38 to 6·00 times in the length of the head, 1·20 times in the length of the snout and from 1·20 to 1·33 times in the interorbital width. The two nostrils of each side are well marked and are placed nearer the tip of the snout than the eye. The median groove on the head is broad and extends from between the nostrils to the base of the occipital process; the lateral edges of the groove are raised into slightly elevated longitudinal ridges. At the sides of the groove in the posterior region of the head there are two pairs of fontanels. The occipital process is broad and long; it is almost twice as long as broad at the base and almost extends to the basal bone of the dorsal fin. The mouth is inferior, crescentic and horizontal; its width is almost equal to the length of the snout. The lips are visible as definite structures only near the angles of the mouth. The teeth are minute and in the upper jaw are situated outside the mouth. There are four pairs of barbels; the nasal barbels are almost as long as the head; the maxillary barbels are provided with stiff basal parts and extend to the anal fin or beyond; the outer mandibular barbels are more than one and a half times as long as head while the inner pair is equal to the head behind the nostrils. The bases of the inner pair of mandibular barbels are situated in front of those of the outer pair. The gill-openings are wide

and on the ventral surface extend anteriorly to the median line; the gill-membranes are united with each other.

The depth of the body is contained from 6·90 to 8·37 times in the standard length. The least height of the caudal peduncle is contained from 2·20 to 2·75 times in its length. The portion of the body where the air-bladder comes in contact with the skin is not well marked externally. The cubito-humeral processes are, however, well developed.

The commencement of the dorsal fin is situated well in advance of that of the pelvics, but its base extend over the pelvic fins; its longest ray is greater than the head but the spine is somewhat shorter. The dorsal spine is a strong prickle which is smooth along both the edges. The adipose dorsal is short but well marked. The paired fins are horizontally placed, they are somewhat shorter than the head and are separated from the pelvic fins by a considerable distance. The pectoral spine is strong and broad; it is smooth along the outer border but is strongly denticulated internally. The pelvic fins are long and pointed; they extend beyond the anal opening but do not reach the base of the anal fin. The caudal fin is deeply forked with both the lobes sharply pointed.

Hamilton noted that the colours of *Gagata nangra* " are rather agreeable, being silver, with some green on the back, and a faint brown streak across the foremost back fin, and another across the fin of the tail". According to Day, the colour is " muddy, with three indistinct vertical greenish half bands". In the specimens examined by us, there is a short, faint longitudinal band below the base of the dorsal fin and another along the lateral line. There is a vertical bar at the base of the caudal fin and the dorsal surface of the head is dusky.

Distribution.—Hamilton found this species in the Kosi river, but Day extended its range to the Ganges, Jumna and Indus. The two specimens of *G. nangra* examined by us were collected from the river Hooghly at Nawabgunj.

This species can be readily distinguished by its longer barbels, pointed snout and extensive gill-openings.

Measurements in millimetres.

Standard length	33·5	34·5
Length of head	8·0	9·0
Height of head at occiput	4·0	4·5
Width of head	7·5	6·0
Length of snout	1·8	1·8
Diameter of eye	1·5	1·5
Interorbital width	1·8	2·0
Depth of body	4·0	5·0
Length of caudal peduncle	5·5	5·5
Least height of caudal peduncle	2·0	2·5
Longest ray of dorsal	9·0	10·0
Length of dorsal spine	7·0	8·0
Length of pectoral	6·8	8·0
Length of pectoral spine	5·2	6·5
Length of ventral	6·0	6·8
Longest ray of anal	7·4	9·5
Length of base of anal	5·0	5·0
Length of base of adipose dorsal	5·5	7·0

X. FISHES OF THE GENUS *Batasio* BLYTH.

In the preceding article of this series, attention is directed to the fact that considerable confusion prevails regarding the taxonomic validity and the generic limits of *Batasio* Blyth, and reference has been made to the more salient features by which it can be distinguished from the superficially allied genus *Gagata*. In this article we give a detailed historical and taxonomic account of the genus, and descriptions of the species which we assign to it. A new species of *Batasio* has been discovered from Travancore, S. India, and the range of one of the Indian species, *B. tengana*, has recently been extended by Hora and Gupta[1] to the Malay Peninsula. These new records of the distribution of the genus from such widely separated localities are very significant from a zoogeographical point of view and lend considerable support to the hypothesis advanced by one of us[2] that the similarity in the fish-fauna of the Malay Region and of South India is due to the migration of the southern Chinese fishes to both the regions along mountain ranges at a time when the geographical features of these countries were different from what they are to-day. The migration of *Batasio* from Burma and Assam to Travancore was probably along the old Satpura trend of mountains as far as the Western Ghats and thence along the Ghats to the south of the Peninsula.

Batasio Blyth.

1860. *Batasio,* Blyth, *Journ. As. Soc., Bengal* XXIX, p. 149.
1862. ? *Batasio,* Bleeker, *Atl. Ichthyol.* II, p. 9.
1863. ? *Batasio,* Bleeker, *Ned. Tijds. Dierk.* I, p. 94.
1921. *Macronoides,* Hora, *Rec. Ind. Mus.* XXII, p. 179 (1921).

In 1860, Blyth[3] established the genus *Batasio* to accommodate a group of Bagroid fishes and characterised it as follows :—

"A Bagroid form well worthy of distinction; comprising a number of small species with round and prominent muzzle, and the contracted mouth opening from below: with eight, or sometimes (?) six, cirri, which are very short, the maxillary cirri scarcely passing the eye in some. Palatal band of teeth continuous with the mass of maxillary teeth, or separated only by a slight groove. Rest as in *Bagrus* (*verus*).

"Type. *B. Buchanani*, nobis; *Pimelodus batasio*, H. B."

Blyth did not examine any specimen of Hamilton's[4] *Pimelodus batasio*, but described a new species, *B. affinis*, from Tenasserim. He observed that :—

"To the same type, but with shorter adipose dorsal, appertain the *tengana*, *chandamara* and *rama* of Buchanan Hamilton. *B. chandamara* is referred to *Silundia* by M. Valenciennes, and is described by Hamilton to have only two cirri; but his unpublished figure represents six cirri distinctly, and in all this group the minute cirri are discernible with difficulty and are extremely liable to be overlooked. To *Bagrus capenses* of Sir A. Smith's 'Illustrations of S. African Zoology' would appear also to be referable to this particular division."

Bleeker[5] considered *Batasio* a doubtful genus, but assigned it to the phalanx *Bagrichthyes* and stirps Bagrini. Günther[6] evidently regarded

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[1] Hora, S. L. and Gupta, J. C., *Bull. Raffles Mus. Singapore*, No. 17 (1941).
[2] Hora, S. L., *Rec. Ind. Mus.* XXXIX, pp. 255, 256 (1937); *Proc. Nat. Inst. Sci. India* IV, p. 405 (1938).
[3] Blyth, E., *Journ. As. Soc. Bengal* XXIX, pp. 149, 150 (1860).
[4] Hamilton, F., *Fish. Ganges*, p. 179 (Edinburgh, 1822).
[5] Bleeker, P., *Ned. Tijds. Dierk.* I, p. 94 (1863).
[6] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 83 (1864).

it as a synonym of *Macrones*, for he described both *Pimelodus batasio* Ham. and *Batasio affinis* Blyth in this genus. Day[1] included it under *Gagata* and remarked in a footnote as follows :—

> "Genus *Batasio*, Blyth, is said to comprise fishes with the barbels shorter than the head and teeth on the palate, examples: *Pimelodus batasio*, H. B. (*the* author merely says of the teeth, that those 'in both jaws are crowded'), *P. tengana*, H. B., *B. affinis*, Blyth, *P. rama*, H. B. The two first probably belong to genus *Gagata*, the third to *Macrones*, and the last two to *Liocassis*."

Vinciguerra[2] discussed the systematic position of *Batasio* in regard to *Macrones* and other allied Bagrid genera, but did not consider it distinct from *Macrones*. He described a new species *M. dayi* from Meetan and Toungoo which is stated to be closely allied to *Batasio affinis* Blyth.

Jordan in his 'Genera of Fishes' (p. 294) stated that *Batasio* Blyth replaces *Gagata* Bleeker. In view of the confused taxonomic position of *Batasio*, one of us (S. L. H.) did not realize its generic limits when he created the subgenus *Macronoides*[3] for *Macrones affinis* (Blyth), *M. dayi* Vinciguerra and *M. marianiensis* Chaudhuri.[4] *Macronoides* was characterised as follows :—

> "This new subgenus is proposed for species which differ from typical *Macrones* in the possession of a distinct ventral mouth bordered by fringed lips; in having short barbels not exceeding the length of the head; in the mandibular pairs of barbels being disposed in a transverse row across the mandible and in the possession of open pores on the ventral surface of the head just behind the mouth. In general facies the fish of this subgenus show a remarkable resemblance to those of the genus *Gagata*, from which, however, they are easily distinguished by the crescentic band of teeth and a free air-bladder in the abdominal cavity."

In examining the collection made by Messrs. G. E. Shaw and E. O. Shebbeare from the Terai and Duars, one of us (S. L. H.) found representatives of Hamilton's little known species—*Pimelodus batasio*—and found it to belong to his genus *Macronoides*. He, therefore, suggested to Shaw & Shebbeare[5] to revive Blyth's genus *Batasio* and to describe this fish as *Batasio batasio* (Hamilton).

Having cleared the systematic position of *Batasio* Blyth from a study of the fresh material of *B. batasio* (Ham.) obtained from its type-locality, we may now consider which other species can be assigned to this genus. We have indicated above (*vide supra*, p. 13) that Hamilton's *Pimelodus tengana*,[6] as surmised by Blyth already (*vide supra*, p. 28), belongs to this genus. In a recent collection made by one of us (S. L. H.) from the Terai and Duars there are several specimens which are referable to this species, though the colouration, which is variable, differs from that described by Hamilton. He observed that :—

> "..........The body is diaphanous, with a silver *coloured membrane* investing the viscera and spine, and with a gloss of gold on the sides. On the back are many black dots, which are collected into a spot above each pectoral fin, and also on the crown of the head. The fins of the back and tail also are dotted, so that the edge of the last is black, and several spots are formed on the first."

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[1] Day, F., *Fish. India*, p. 492 (1877).

[2] Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, pp. 211-217, 230-235 (1890).

[3] Hora, S. L., *Rec. Ind. Mus.* XXII, p. 179 (1921).

[4] Chaudhuri, B. L., *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1*a*, 1*b* (1913).

[5] Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, pp. 97, 98, text-fig. 98, 1937 (1938).

[6] Hamilton, F., *Fish. Ganges*, p. 176, pl. xxxix, fig. 58 (Edinburgh, 1822).

Hamilton found this species in the Brahmaputra river at Goalpara. In the adult specimens from the Terai and Duars the colouration is more or less similar to that described by Hamilton but in the younger specimens the body is marked with a few oblique bands and spots, and the distal half of the anterior rays of the dorsal fin is black. On the whole the colour seems to vary considerably with age (*vide infra*, p. 38).

In describing *Batasio affinis*, Blyth[1] remarked :—

> "Exceedingly like *B. Buchanani*, as described by Buchanan Hamilton and as figured in one of his unpublished coloured drawings ; whereas his published figure (F. G. pl. xxiii, f. 60) refers to his *Pimelodus carcio*, which is a true *Bagrus* with moderately long maxillary cirri :—but having 12 instead of 16 anal rays, no distinct longitudinal black stripe on each side of the body, but a tendency to show three or four black broad cross-bands, more or less distinct, besides a round black spot near the gill-covers, as in the other. The first dark band proceeds obliquely downwards from the fore-part of the first dorsal, to some distance below the lateral line ; and posterior to this first band are obscure traces of three or four others, the last at base of tail. On the membrane of the dorsal fin is a large blackish spot, consisting of minute dark specks."

The type of Blyth's species is preserved in the collection of the Indian Museum, and though its colouration has faded there can be no doubt of its identity with the specimen of Hamilton's *Pimelodus tengana* from the Tista River System.

In his 'Supplement' to the 'Fishes of India' (1888, p. 805), Day described *Leiocassis fluviatilis*, a species of freshwater fish found by Day in Col. Tickell's "volume of beautiful coloured drawings of Burmese Fishes with their descriptions", of which Col. Tickell is stated to have "obtained four examples, the largest 3½ inches long from the Anin, a steam rising near Weywoon, Wagroo in the Tenasserim Provinces". The identity of this species is still in doubt, but recently Hora and Gupta examined six specimens from the Chenderoh Lake, Perak, in the collection of the Raffles Museum, Singapore, which they referred to this species. The most characteristic feature of *L. fluviatilis* is its colouration, which, according to Day (*loc. cit.*), is as follows :—

> "Yellowish horny with darker shades of olive brown on the snout and along the back, also some cloudy markings. A large black blotch on the lateral-line above the anal fin, another between the pectoral and first dorsal. Tip of dorsal and ends of both caudal lobes black."

In the examples from Perak the black blotch on the lateral line above the anal fin is very conspicuously marked, while the anterior blotch represents the area against which the air-bladder comes directly in contact with the skin. Another conspicuous feature of these examples is an oblique horseshoe-shaped band lying in front of the first dorsal fin and descending on the sides to below the lateral line. Sometimes this band breaks up into a dorsal blotch and two oblique bars on the sides. There is a submarginal band on the dorsal fin and the tips of the caudal fins are somewhat dusky but not black.

Day observed that with the exception of the maxillary pair of barbels no others were detected. We find that there are two pairs of mandibular barbels, the outer being more or less equal to the diameter of the eye while the inner are very rudimentary. The nasal barbels extend

[1] Blyth, E., *Journ. As. Soc. Bengal* XXIX, p. 149 (1860).

to the front border of the eye or slightly beyond it. The maxillary barbels, as noted by Day, extend as far as the posterior border of the orbit.

A comparison of the Perak examples with those of *Pimelodus tengana* from the Eastern Himalayas and of *Batasio affinis* from Tenasserim leaves little doubt of their identity. We are, therefore, led to conclude that Day's *Leiocassis fluviatilis* is a synonym of *Batasio tengana* (Ham.).

Vincigeurra's[1] *Macrones dayi* is stated to be closely allied to *Leiocassis fluviatilis* Day and *Batasio affinis* Blyth, only differing in proportions and colouration. From a study of a large number of specimens we have found that such differences have no specific value and we are of opinion, therefore, that *M. dayi* is also a synonym of *Batasio tengana* (Ham.). Chaudhuri's[2] *M. marianiensis*, described from the Brahmaputra River System, Assam, and later recorded from the streams at the base of the Eastern Himalayas, is also a synonym of *B. tengana*. The species described and figured by Shaw and Shebbeare[3] as *Leiocassis rama* is also referable to *B. tengana*. Regarding this species Shaw and Shebbeare noted :—

> "In general appearance resembles those species of *Mystus* which have a shoulder-blotch and longitudinal bands but has much shorter barbels. It therefore somewhat resembles *Batasio batasio* from which it is distinguished by having a shorter adipose fin and a longer anal."

Recently we obtained a number of specimens from Travancore in which the body is of deep gray colour and is devoid of any transverse oblique bands or spots. These specimens are of a somewhat larger size and on morphological characters represent a new species of *Batasio*. In the present-day discontinuous distribution of this genus we have another record of the common origin of the fauna of the Malay Peninsula and that of Peninsular India.

Besides *Batasio batasio* (Ham.) and *B. tengana* (Ham.), there are two other species of Hamilton's *Pimelodus* which have been assigned by Blyth to *Batasio, viz., P. chandramara* and *P. rama*. Hamilton[4] recognised the great similarity between these species and separated them on the following characters :—

P. chandramara.	*P. rama.*
1. Two barbels.	1. Six barbels.
2. Diaphanous with clusters of black dots; golden stripe along lateral line.	2. Diaphanous, yellowish without dots. Black spot on nape, divided into four lobes.
3. A. 17.	3. A. 15.

As pointed out by Blyth, Hamilton's original figure of *P. chandramara*[5] shows six distinct barbels. The other two points of difference are not of specific value as the colour may vary according to habitats

[1] Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 230 (1890).
[2] Chaudhuri, B. L., *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1*a*, 1*b* (1913).
[3] Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, p. 90, text-fig. 88, pl. 3, fig. 4, 1937 (1938).
[4] Hamilton, F., *Fish. Ganges*, pp. 162, 176 (Edinburgh, 1822).
[5] *Vide* Hora, S. L., *Mem. Ind. Mus.* IX, pl. xxi, fig. 6 (1929).

and the difference in the number of anal rays may be due to individual variation. Both the species were described from Northern Bengal.[1]

Hamilton's descriptions of both the species are brief and inadeq for their specific determination, and, as pointed out by Blyth (*loc.* there are discrepancies between his descriptions and figures. For instance, Hamilton stated in his description that *P. chandramara* possesses only " two tendrils ", whereas in his unpublished figure 6 barbels are distinctly shown. The consideration of the number of barbels alone seems to have led Swainson[2] and Cuvier & Valenciennes[3] to refer *P. chandramara* to the genera *Silonia* and *Silundia* respectively. It may be stated without any fear of contradiction that Hamilton's species does not belong to either of these genera. Blyth placed it in the genus *Batasio* but without examining any specimen of the species; his conclusion seems to have been based on a study of the unpublished drawing of the species. In the two species of *Batasio* referred to above, there is a distinct nasal barbel, which is neither described nor shown in the figure of *Pimelodus chandramara*. Günther[4] referred *P. rama* very doubtfully to the genus *Rita*, but considering the large size of its eyes, general facies and habitat, it is difficult to place it among *Rita*. Day[5] examined a specimen from Assam, which undoubtedly belongs to this species and regarded it as *Leiocassis*.[6] On a careful analysis of Day's description it is found that the species shows affinities with both *Batasio* and *Leiocassis*. For instance, the subcutaneous nature of the eyes is a character of *Leiocassis*, but their relatively large size is a character of *Batasio*. The absence of the nasal barbels, however, precludes it from either of the genera. We have examined Day's specimen from Assam, which is in a poor state of preservation, and have found open pores along the lower jaw and edges of the gill-covers which are characteristic of *Batasio*. In view of what is stated above, and in the absence of good and reliable material it is perhaps desirable to keep *Pimelodus rama* in a separate genus for which Bleeker has already proposed the name *Rama*.

In 1931, H. M. Smith[7] described from Siam a strikingly marked little catfish and referred it to the genus *Mystus*. The colouration and general build of this species, *M. havmolleri*, are very similar to

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najpur dis... In Purnian he records it as termed Khămaĭñ at Bholáhát. In the 'Fishes of the Ganges', he remarks that *P.* from the Brahmaputra. The fish I have here described from the same locality, appears to be a link between the two forms, as the Assam one is said to have on nape a large black spot divided into four lobes, and which is not present in my specimens, which it is said to differ from *P. chandramara*, chiefly in the latter being deficient in this mark. I have referred my specimen to *P. rama* as it came from Assam.

[2] Swainson, W., *Nat. Hist. Classification Fish. Amph. Rept.* II, p. 305 (1839).

[3] Cuvier, G. and Valenciennes, A., *Hist. Nat. Poiss.* XV, p. 49 (1840).

[4] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 92 (1864).

[5] Day, F., *Fish. India*, p. 451 (London, 1877).

[6] Regan [*Ann. Mag. Nat. Hist.* (8) II, p. 547, 1913] observed that " *Pimelodus rama* Ham. Buch., from Bengal and Assam, is placed by Day in *Liocassis* (*Fish. India*, p. 451 pl. cxv, fig. 2); it seems improbable that this little fish really belongs to the genus; but if it does, the large eye and minute mandibulary barbels distinguish it from all the other species".

[7] Smith, H. M., *Proc. U. S. Nat. Mus.* LXXIX, Art. 7, p. 24, fig. 24 (1931).

Batasio tengana, though in the size of its eyes, barbels and adipose dorsal it is somewhat different. It is stated to be provided with "a transverse row of 4 large pores behind lower lip; entire snout thickly beset with minute pores". A more detailed description of the species is necessary to determine its precise specific limits but there can hardly be any doubt of its position in the genus *Batasio*. In fact, its resemblance to *B. tengana* is so close that, in the present state of our knowledge we consider that the differences between the two are not of specific value.

From the above it will be clear that in the present state of our knowledge only three Indian species can definitely be assigned to the genus *Batasio*. These can be distinguished by the following key:—

Key to the Indian species of Batasio *Blyth.*

A. Base of adipose dorsal considerably longer than that of anal.
  I. Body marked with longitudinal bands; a conspicuous dark spot above pectoral. [Median groove on head continued on occipital process for some distance; occipital process extending over basal bone of dorsal and meeting first dorsal spine; no pores on dorsal surface of head.] .. .. *B. batasio.*
  II. Body without longitudinal bands or spots. [Median groove on head extending to base of occipital process; occipital process separated from basal bone of dorsal fin by a considerable distance; pores on dorsal surface of head present] .. .. *B. travancoria.*

B. Base of adipose dorsal shorter or equal to base of anal. [Median groove on head extending to end of occipital process and in its posterior portion containing basal bone of dorsal fin; no pores on dorsal surface of head; body marked with oblique vertical bands or spots.] .. .. *B. tengana.*

Batasio batasio (Hamilton).

Plate II, figs. 4-6.

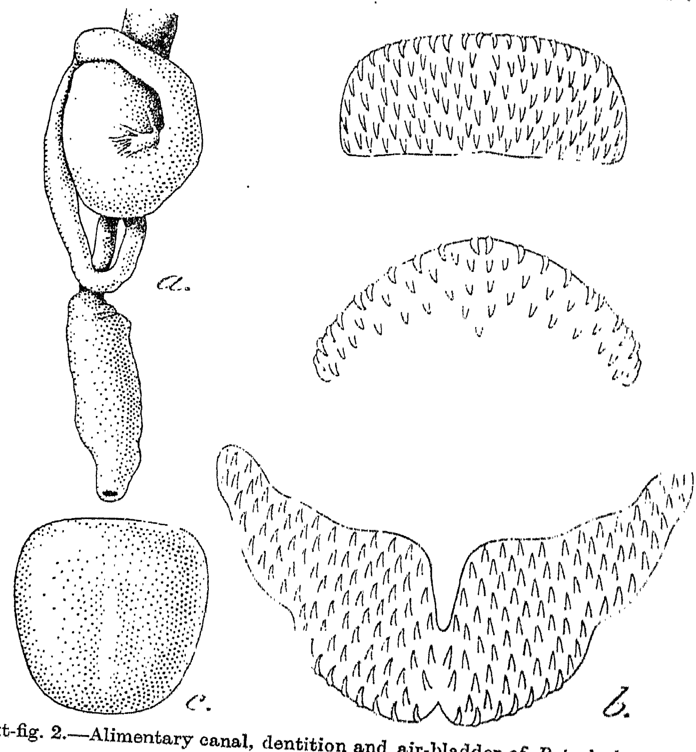
1822. *Pimelodus batasio,* Hamilton, *Fish. Ganges,* pp. 179, 377. (The drawing on pl. xxiii, fig. 60 does not refer to this species, but to *P. carcio* described on p. 181).
1839. *Bagrus batasio,* Cuvier and Valenciennes, *Hist. Nat. Poiss.* XIV, p. 425.
1860. *Batasio Buchanani,* Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
1862. ? *Batasio Buchanani,* Bleeker, *Atl. Ichthyol.* II, p. 8.
1863. ? *Batasio Buchanani,* Bleeker, *Ned. Tijdschr. Dierkund.* I, p. 94.
1864. *Macrones batasio,* Günther, *Cat. Fish. Brit. Mus.* V, p. 83.
1877. *Gagata batasio,*Day, *Fish. India,* p. 493, pl. xcix, fig. 5 (Hamilton's MS. drawing reproduced).
1889. *Gagata batasio,* Day, *Faun. Brit. Ind. Fish.* I, p. 209.
1929. *Pimelodus batasio,* Hora, *Mem. Ind. Mus.* IX, pl. xxii, fig. 3.
1938. *Batasio batasio,* Shaw and Shebbeare, *Journ. Roy. As. Soc. Bengal, Science* III, p. 97, fig. 98.

D. 2/7; A. 3-4/9-10; P. 1/5-8; V. 1/5; C. 17.

Batasio batasio is a medium-sized species in which the dorsal and the ventral profiles are moderately arched. The dorsal profile rises gradually from the tip of the snout to the origin of the dorsal fin whence it slopes down gradually to caudal peduncle where it is horizontal. The ventral profile is horizontal and flattish just for a short distance between the head and pelvic fins, thence it rises gradually towards

both ends. The body is compressed from side to side, more so in the tail region.

The head is sharp, bluntly pointed and conical; its length is contained from 3·61 to 3·90 times in the standard length. The height of the head is contained from 1·34 to 1·71 times and its width from 1·43 to 2·38 times in its length. The snout is fairly long and pointed; it projects in front of the mouth for a short distance. The eyes are of a moderate size and dorso-lateral in position; they are not visible from the ventral surface. The orbital margins are free. The diameter of the eye is contained from 2·63 to 3·30 times in the length of the head, from 1·14 to 1·53 times in the length of the snout and from 0·71 to 1·20



Text-fig. 2.—Alimentary canal, dentition and air-bladder of *Batasio batasio* (Hamilton).

a. Alimentary canal: ×2½. *b.* Dentition: ×12. *c.* Air-bladder: ×2½.

times in the interorbital width. The two nostrils of each side are wide apart and are not so conspicuous as in the species of *Gagata*. The anterior nostril is placed above the base of the maxillary barbel and much nearer the tip of the snout than the eye; while the second pair is closer to the eye than to the anterior nostril. The median groove on the head is long and narrow; it extends from between the posterior nostrils to one-third of the occipital process; the lateral edges of the groove are slightly raised into longitudinal ridges. In the groove,

there are two fontanels which are separated by a broad bony ridge; the anterior fontanel extends over the anterior two-thirds of the eye, while the posterior fontanel commences from behind the eye and extends for a short distance over the occipital process. The occipital process is long and broad; its length is almost $3\frac{1}{2}$ times its width at the base; it extends over the basal bone of the dorsal fin. The mouth is inferior, crescentic and horizontal; it is bordered by fleshy lips which are continuous at the angles of the mouth. The labial groove is broadly interrupted in the middle; both the lips are distinctly fimbriated. Behind the lower lip there are four slit-like openings and four pairs of pores on the ventral surface of head running obliquely from the mandibular barbels to the gill-openings. The teeth are small and villiform; they are arranged in broad continuous bands in the jaws and in a similar band on the palate. There are four pairs of barbels; the nasal barbels, which are placed at the anterior end of the posterior nostrils, are small and considerably shorter than the diameter of the eye; the maxillary barbels do not extend beyond the posterior margin of the orbit and the mandibular barbels are still shorter; the bases of the latter are not situated exactly in a transverse line behind the lower lip, but those of the inner pair are slightly in advance of those of the outer. The gill-membranes are notched anteriorly and the gill-openings are very extensive.

The depth of the body is contained from 3·72 to 4·40 times in the standard length. The least height of the caudal peduncle is contained from 1·33 to 1·57 in its length. The portion of the body where the air-bladder comes in contact with the skin is well marked externally. The cubito-humeral processes are also well developed. The external features of the urino-genital organs are similar to those as described above in the species of *Gagata* (*vide supra*, p. 16). In ripe males the urinogenital papilla is well marked.

The rayed dorsal fin is situated well in advance of that of the pelvics, but its base extends almost over the pelvic fins; its longest ray is shorter than the length of the head and the spine is much shorter. The dorsal spine is a strong prickle which is smooth along both the borders. The adipose dorsal is considerably long and well marked; the length of its base is equal to or greater than the length of its head. The pectoral fins are horizontally placed and are shorter than the head; they are separated from the pelvic fins by a considerable distance. The pectoral spine is strong and broad; it is smooth along the outer border but is strongly denticulated internally. The pelvic fins extend beyond the anal opening but do not reach the base of the anal fin. The caudal fin is deeply forked with both the lobes sharply pointed.

Hamilton noted that the fish is provided "with a diaphanous body, having on each side two stripes dotted with black .... The cavity containing the viscera is lined with a silver *coloured* membrane; and, besides the two stripes, the fish has on each shoulder a spot composed of black dots. The first dorsal fin is spotted, the second is dotted." Shaw and Shebbeare described the colouration as follows :—

"Leaden above, yellow beneath. A dark longitudinal band along the lateral line expanding into a shoulder-blotch immediately below the dorsal fin. A second fainter and somewhat curved dark band midway between the lateral line and the

dorsal ridge, commencing at the top of the opercle and ending about the middle of the adipose fin. It is connected with the dark colour of the dorsal ridge at the front part of the rayed dorsal."

Distribution.—Batasio batasio is known so far from the Tista River System. We have examined several specimens from the streams of Terai and Duars.

Measurements in millimetres.

Standard length	55·0	65·0	69·0	75·0	84·0	89·5
Length of head	14·5	18·0	19·0	20·5	21·5	23·0
Height of head at occiput ..	9·5	10·5	13·0	14·0	16·0	15·0
Width of head	9·0	10·0	12·5	13·8	9·0	16·0
Length of snout	6·5	7·5	8·0	8·0	10·0	10·0
Diameter of eye	5·5	6·0	7·0	7·0	6·5	7·0
Interorbital width	4·5	5·0	5·0	5·0	6·0	6·5
Depth of body	12·5	15·0	18·5	17·5	23·5	23·0
Length of caudal peduncle ..	8·0	9·0	11·0	11·0	12·5	12·0
Least height of caudal peduncle..	5·5	6·5	7·0	8·0	8·5	9·0
Longest ray of dorsal ..	10·0	11·5	13·0	14·0	D.	14·5
Length of dorsal spine ..	9·0	12·0	9·5	12·0	D.	D.
Length of pectoral	11·0	12·0	14·0	13·0	14·5	14·0
Length of pectoral spine ..	10·0	11·0	12·0	D.	13·0	13·0
Length of ventral	8·5	12·0	10·0	11·0	10·5	13·0
Longest ray of anal	11·0	9·5	9·5	11·5	15·5	D.
Length of base of anal ..	10·5	10·0	12·0	11·5	14·5	11·0
Length of base of adipose dorsal .	19·0	16·5	19·0	22·0	21·5	23·0

Batasio tengana (Hamilton).

Plate II, figs. 1-3.

1822. *Pimelodus tengana,* Hamilton, *Fish. Ganges,* pp. 176, 377, pl. xxxix, fig. 58.
1839. *Bagrus tengana,* Cuvier & Valenciennes, *Hist. Nat. Poiss.* XIV, p. 433.
1854. *Bagrus tengana,* Bleeker, *Verh. Bat. Gen.* XXV, p. 56.
1860. *Batasio affinis,* Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
1860. *Batasio tengana,* Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
1864. *Macrones affinis,* Günther, *Cat. Fish. Brit. Mus.* V, p. 83.
1864. *Macrones tengana,* Günther, *Cat. Fish. Brit. Mus.* V, p. 84.
1873. *Macrones affinis,* Day, *Proc. Zool. Soc. London,* p. 111.
1877. *Macrones Blythii,* Day, *Fish. India,* p. 445.
1877. *Gagata tengana,* Day, *Fish. India,* p. 493.
1888. *Leiocassis fluviatilis,* Day, *Fish. India Suppl.,* p. 805.
1889. *Liocassis fluviatilis,* Day, *Faun. Brit. Ind. Fish.* I, p. 164.
1889. *Macrones blythii,* Day, Faun. *Brit. Ind. Fish.* I, p. 151.
1889. *Gagata tengana,* Day, *Faun. Brit. Ind. Fish.* I, p. 210.
1890. *Macrones Dayi,* Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 230, pl. vii, fig. 3.
1913. *Macrones marianiensis,* Chaudhuri, *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1*a*, 1*b*.
1921. *Macrones* (*Macronoides*) *affinis,* Hora, *Rec. Ind. Mus.* XXII, p. 180.
1921. *Macrones* (*Macronoides*) *merianiensis,* Hora, *Rec. Ind. Mus.* XXII, p. 736.
1931. *Mystus havmolleri,* H. M. Smith, *Proc. U. S. Nat. Mus.* LXXIX, art. 7, p. 24, fig. 12.
1937. *Leiocassis rama,* Shaw & Shebbeare (*nec* Hamilton), *Journ. Roy. Asiat. Soc. Bengal, Science* III, p. 90, text-fig. 88, pl. iii, fig. 4.

D. 2/7-8; A. 3-4/8-11; P. 1/7-9; V. 1/5; C. 16-18.

Batasio tengana is a small, well-built species in which both the dorsal and the ventral profiles are somewhat arched; the body is deepest about the commencement of the dorsal fin and from that point it tapers both anteriorly and posteriorly. The ventral surface between the pectorals is only slightly flattened, but that of the head is flattish. The fish is compressed from side to side; this is more marked in the tail region.

The head is broadly pointed anteriorly and the snout is produced beyond the mouth for a short distance. The length of the head is contained from 3·58 to 4·17 times in the standard length; the height of the head is contained from 1·35 to 1·78 times and its breadth from 1·36 to 1·70 times in its length. The eyes are of a moderate size and are dorso-lateral in position; they are not visible from the ventral surface, and are situated almost in the middle of the length of the head. The diameter of the eye is contained from 2·50 to 3·40 times in the length of the head and from 0·87 to 1·4 times in the length of the snout. The interorbital distance is considerably less than the diameter of the eye. The nostrils are situated wide apart; the anterior nostril is tubular and directed forwards; the posterior nostril is situated almost midway between the eye and the tip of the snout and is provided with a nasal barbel at its anterior end. The median groove on the head is long and narrow; it extends from behind the posterior nostrils to the end of the occipital process; its margins form slightly elevated ridges. In the groove, there are two median fontanels which extend to the base of the occipital process and are separated from each other by a narrow ridge situated behind the eyes. The anterior part of the basal bone of the dorsal fin is lodged in the median groove of the occipital process, which is long and narrow. The mouth is small, inferior, horizontal and crescentic; it is bordered by fleshy lips which are continuous and pendulous at the corners of the mouth. The labial groove is broadly interrupted in the middle; both the lips are distinctly fimbriated. Behind the lower lip there are five slit-like oval openings and four pairs of small round holes situated obliquely between the bases of the mandibular barbels and the gill-openings. The teeth are small and villiform; those in the jaws form oval patches while those on the palate form a lunate band. There are four pairs of barbels; the nasal barbels extend to the anterior border of the orbit or a little farther; the maxillary barbels are the longest but are just about half the length of the head and the mandibular barbels are considerably shorter. The bases of the mandibular barbels are situated at a considerable distance behind the mouth and are not in a straight line, those of the inner pair being somewhat in advance of those of the outer. The gill-openings are very extensive and the gill-membranes are deeply notched anteriorly.

The depth of the body is contained from 3·69 to 4·65 times in the standard length. The least height of the caudal peduncle is contained from 0·84 to 1·60 times in its length. The portion of the body where the air-bladder comes in contact with the skin is well-marked. The cubito-humeral processes are narrow and can be readily felt through

the skin. The external features of the urinogenital organs are similar to those of *Batasio batasio.*

The rayed dorsal fin is situated considerably in advance of the pelvic fins, but its base extends almost over their commencement. The longest ray of the dorsal fin is considerably shorter than the head and the spine is still shorter. The dorsal spine is a smooth, moderately strong prickle. The adipose dorsal, though well marked, is not so extensive as that of *B. batasio* ; it commences considerably behind the rayed dorsal and its base is somewhat shorter than the head. The pectoral fins are situated slightly above the ventral surface of the body ; they are much shorter than the head and are separated from the pelvic fins by a considerable distance. The pectoral spine is flattened and strong ; it is smooth externally but strongly denticulated internally. The pelvic fins are shorter than the pectorals and extend beyond the anal opening but not as far as the urinogenital openings. The anal fin is situated below the adipose dorsal and its base is slightly longer than that of the rayed dorsal. The caudal fin is deeply forked, with the lower lobe somewhat better developed ; both the lobes are bluntly pointed.

As indicated above (*vide supra,* p. 30), the colour varies considerably with the size of the specimens and locality. In fresh specimens collected from the streams of Terai and Duars, Tista River System, the general surface is gray-olivaceous which is deeper above and lighter below. The dorsal surface of the head is dark with an indication of a band in the region of the eyes ; this band passes on the sides below the eyes but does not extend to the ventral surface. There is a broad black spot on the nape. Behind the head there is an oblique darkish band dorsally which extends to the sides and joins the black blotches in the region above the pectorals where the air-bladder comes in contact with the skin. The rest of the body is marked with five oblique, saddle-shaped bands of varying depth of colour which do not extend to the ventral surface, the first is at the commencement of the rayed dorsal fin, the second at its termination, the third below the anterior part of the adipose dorsal, the fourth below the posterior part of the adipose dorsal and the last in front of the base of the caudal fin. The distal portions of the anterior rays of the dorsal fin are dark and form a broad patch. The other fins are somewhat dusky. The colour variations consist in the suppression or intensification of some of these markings, but the general colour plan remains more or less similar. For this reason we have attached no significance to colour variations in recognising species established on this character alone.

Distribution.—*Batasio tengana* was originally described from the Brahmaputra river. We have examined several specimens from below the Darjeeling Himalayas, Assam, Tenasserim, Mergui and Perak. It is also found in Siam (Klong Thalerng, near Ronpibun, Peninsular Siam), from where it was described as *Mystus havmolleri* by H. M. Smith. In the Siamese examples the eyes are considerably smaller and the adipose dorsal relatively longer. As judged from the figure the barbels, especially the maxillary pair, appear to be somewhat longer. In view of these differences it may perhaps be desirable to regard *M. havmolleri* as a variety of *B. tengana.*

Measurements in millimetres.

	Bengal.										Assam.				Tenasserim.	Tasing, Mergui Expedition.	Chenderoh Lake, Perak.	
Standard length ..	38·5	40·0	43·5	46·0	48·0	49·0	54·5	54·5	56·0	60·0	41·5	57·5	64·5	68·5	63·0	74·0	53·5	61·0
Length of head ..	10·5	11·0	11·0	12·5	11·5	13·0	15·0	14·5	13·5	15·0	10·0	15·5	16·5	17·5	16·5	20·5	14·0	17·0
Height of head at occiput ..	6·5	6·5	7·0	9·0	7·0	9·0	8·5	9·0	10·0	9·5	6·5	9·5	11·0	11·0	11·0	15·0	10·0	9·5
Width of head ..	7·0	7·0	7·0	8·0	7·0	9·5	9·5	9·5	9·5	10·0	6·5	9·8	12·0	11·5	11·5	14·5	10·0	10·0
Length of snout ..	3·5	4·0	4·0	4·5	4·0	5·0	5·5	5·5	5·0	6·0	4·0	5·5	6·0	6·0	5·5	8·5	6·0	7·0
Diameter of eye ..	4·0	3·5	3·5	4·0	3·5	4·5	4·5	4·5	4·5	4·5	4·0	5·0	5·0	5·5	6·0	7·0	5·0	5·0
Interorbital width ..	3·0	3·0	3·0	3·0	3·0	3·5	4·0	3·5	4·0	4·0	2·5	3·5	4·0	4·5	5·0	5·0	4·0	4·0
Depth of body	9·0	9·0	10·5	11·5	10·5	11·5	12·0	13·0	14·5	15·0	9·5	14·5	14·5	18·5	16·0	19·5	12·5	16·5
Length of caudal peduncle	5·0	6·5	8·0	8·0	8·0	6·5	8·0	7·0	11·0	10·5	6·0	9·0	10·0	10·0	7·0	9·0	5·5	7·5
Least height of caudal peduncle	4·5	5·0	5·0	5·7	5·5	5·5	6·5	6·0	7·0	7·0	4·0	6·0	7·5	8·5	7·8	8·0	6·5	6·5
Longest ray of dorsal ..	8·0	9·0	9·5	10·0	10·0	11·0	12·0	11·5	10·5	13·0	9·0	11·0	13·0	12·0	D.	16·0	10·0	11·5
Length of dorsal spine ..	6·5	7·0	7·0	8·5	7·5	8·0	9·0	9·0	9·0	10·0	5·5	8·0	10·0	9·5	9·5	9·5	7·0	7·0
Length of pectoral ..	8·5	9·0	10·5	8·5	10·5	9·0	11·5	11·0	12·0	10·0	9·0	10·5	14·5	14·0	11·0	17·0	12·0	11·5
Length of pectoral spine ..	7·5	9·5	8·0	8·0	8·5	8·0	9·0	8·5	9·5	D.	6·5	8·0	10·5	10·5	10·0	13·0	9·5	8·0
Length of ventral ..	6·5	6·5	8·0	7·5	7·0	6·5	8·0	10·0	9·0	9·5	6·0	9·0	10·5	9·5	9·5	12·0	9·0	9·5
Longest ray of anal ..	8·0	6·0	9·0	8·0	10·0	9·5	8·5	11·0	9·5	12·5	8·5	9·5	13·5	13·5	11·0	D.	10·0	10·5
Length of base of anal ..	6·0	6·5	6·0	7·0	6·5	8·0	7·0	8·5	7·0	10·5	5·5	8·5	10·0	10·0	9·0	12·0	8·0	6·0
Length of base of adipose dorsal.	8·5	10·0	7·5	10·5	12·5	9·5	13·0	12·0	11·5	14·0	7·0	10·5	14·0	17·5	13·5	22·5	13·5	16·0

Batasio travancoria, sp. nov.

Plate II, figs. 7-9.

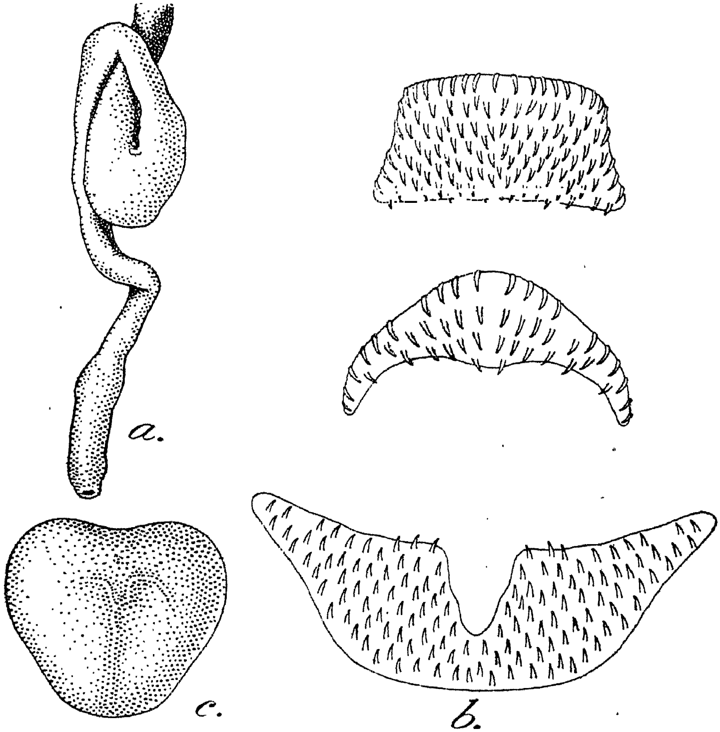
D. 2/7 ; A. 3-4/9-11 ; P. 1/7-9 ; V. 1/5 ; C. 16-19.

Batasio travancoria is an elongated, medium-sized fish, in which the dorsal profile is slightly arched while the ventral profile is more or less horizontal in front of the pelvic fins, after which it is slightly arched. The ventral surface of the head and the anterior part of the body are somewhat flattened. The fish is subcylindrical anteriorly and compressed posteriorly.

The head is globular, conical and rounded anteriorly ; its length is contained from 3·87 to 4·35 times in the standard length. The height of the head is contained from 1·44 to 1·81 times and its width from 1·32 to 1·53 times in its length. The snout is rounded and projects beyond the mouth for a short distance ; it is longer than the postorbital part of the head. The eyes are of a moderate size and are dorso-lateral in position ; they are not visible from the ventral surface. The diameter of the eye is contained from 2·72 to 3·10 times in the length of the head, from 0·93 to 1·28 times in the length of the snout and from 0·50 to 0·81 times in the interorbital width. The nostrils are situated wide apart ; the anterior nostrils are tubular and are directed forwards while the posterior nostrils are situated much nearer the eye than the anterior nostrils and are provided with nasal barbels. The median groove on the head is long and narrow ; it extends from slightly in front of the posterior nostrils to the base of the occipital process or slightly farther and in it are lodged two fontanels separated by a narrow ridge. At the sides of the median groove there is a series of 3 small fontanels on either side. The occipital process is long and sharply pointed posteriorly ; it is separated from the basal bone of the dorsal fin by a considerable distance. The mouth is small, inferior, lunate and horizontal ; it is bordered by fleshy lips which are pendulous and continuous at the angles of the mouth ; the labial groove is widely interrupted. The lips are slightly crenulate but not fimbriate as in the other two species. There are five large oval pores behind the lower lip and two series of six pores each situated obliquely between the angle of the mouth and the gill-cover. There are pores between the nostrils, below the eyes and along the free borders of the gill-covers. The teeth are small and villiform ; they are arranged in bands in the jaws and on the palate. There are eight barbels ; the nasal barbels are situated at the anterior border of the posterior nostrils and extend to about the middle of the eye ; the maxillary barbels are short and do not extend beyond the eyes ; the outer mandibular barbels are as long as the nasal barbels while those of the inner pair are much shorter. The bases of the mandibular barbels are not situated in a straight line ; those of the inner pair are in advance of those of the outer. The gill-openings are extensive and the gill-membranes are notched anteriorly.

The depth of the body is contained from 4·86 to 5·48 times in the standard length. The least height of the caudal peduncle is contained from 1·01 to 1·29 times in its length. The portion of the body where

the air-bladder comes in contact with the skin is fairly well marked externally, and the cubito-humeral processes can be readily felt through the skin. The external features of the urinogenital organs are similar to those described for the other species. The urinogenital papilla is well marked, especially in the males.



Text-fig. 3.—Alimentary canal, dentition and air-bladder of *Batasio travancoria*, sp. nov.
a. Alimentary canal. ×*ca* 2½. *b*. Dentition : ×15. *c*. Air-bladder.

The rayed dorsal fin is situated almost entirely in advance of the pelvics ; its longest ray is considerably shorter than the head. The dorsal spine is comparatively weak and is slightly crenulated along both the borders ; it is slightly longer than half the length of the head. The adipose dorsal commences as a slightly raised ridge behind the base of the rayed dorsal, but after the termination of the dorsal when laid flat it becomes a long, prominent ridge ; the length of its base is considerably greater than the length of the head. The pectoral fin is considerably shorter than the head and is separated from the pelvics by about half of its length. The pectoral spine is moderately developed ; it is smooth externally but denticulated internally. The pelvic fins are horizontal and extend considerably beyond the anal opening to the urinogenital papilla. The anal fin is low and the length of its base is almost equal to the base of the rayed dorsal fin. The caudal fin is

deeply forked with the lobes rounded ; the lower lobe is better developed than the upper.

The colouration in spirit is uniformly gray with the exception of a narrow dark streak along the lateral line. The gray colour is somewhat deeper on the head and the dorsal surface and lighter on the side. The ventral surface is much lighter. All the fins are more or less dusky.

Distribution.—*Batasio travancoria* is represented in the collection of the Zoological Survey of India by five specimens, which were collected by Dr. C. C. John from the following localities in Travancore :

Locality.	No. of specimens.
Peruntenaruvi, a tributary of the Pamba R., at Edakadathy	1
Kolathupuzha, a tributary of the Kallada R. ..	2
Chittar R., Palode	1
Kallada R., 4 miles east of Thenmalai.. ..	1

Type-specimen.—F. 13449/1, Zoological Survey of India (*Indian Museum*), Calcutta.

Measurements in millimetres.

Standard length	56·5	59·0	65·0	74·0	79·0
Length of head	14·5	15·0	15·5	17·0	20·5
Height of head at occiput	8·0	10·0	10·0	11·8	14·0
Width of head	10·0	9·8	11·2	12·8	14·5
Length of snout	5·0	5·7	6·4	6·5	7·0
Diameter of eye	5·2	5·5	5·0	5·5	7·5
Interorbital width..	3·8	3·0	4·0	4·5	3·7
Depth of body	11·5	11·5	12·0	15·2	14·5
Length of caudal peduncle	7·5	6·6	8·0	10·0	9·5
Least height of caudal peduncle ..	5·8	6·5	6·5	8·0	8·5
Longest ray of dorsal	11·3	12·0	12·4	14·0	15·0
Length of dorsal spine	8·5	9·0	9·5	10·0	10·5
Length of pectoral..	12·0	11·5	12·0	13·4	15·2
Length of pectoral spine	10·0	10·0	10·0	11·0	12·0
Length of ventral	9·0	10·0	11·0	12·0	12·5
Longest ray of anal	11·0	11·5	10·4	10·8	11·8
Length of base of anal	8·5	8·0	9·0	11·0	12·5
Length of base of adipose dorsal ..	21·0	17·8	22·8	24·0	30·5

EXPLANATION OF PLATE I.

Indian species of *Gagata* Bleeker.

Gagata gagata (Hamilton).

FIG. 1.—Ventral surface of head and anterior part of body. *Nat. Size.*
FIG. 2.—Dorsal surface of head and anterior part of body. *Nat. Size.*

Gagata itchkeea (Sykes).

FIG. 3.—Ventral surface of head and anterior part of body. $\times 2$.
FIG. 4.—Dorsal surface of head and anterior part of body. $\times 2$.

Gagata cenia (Hamilton).

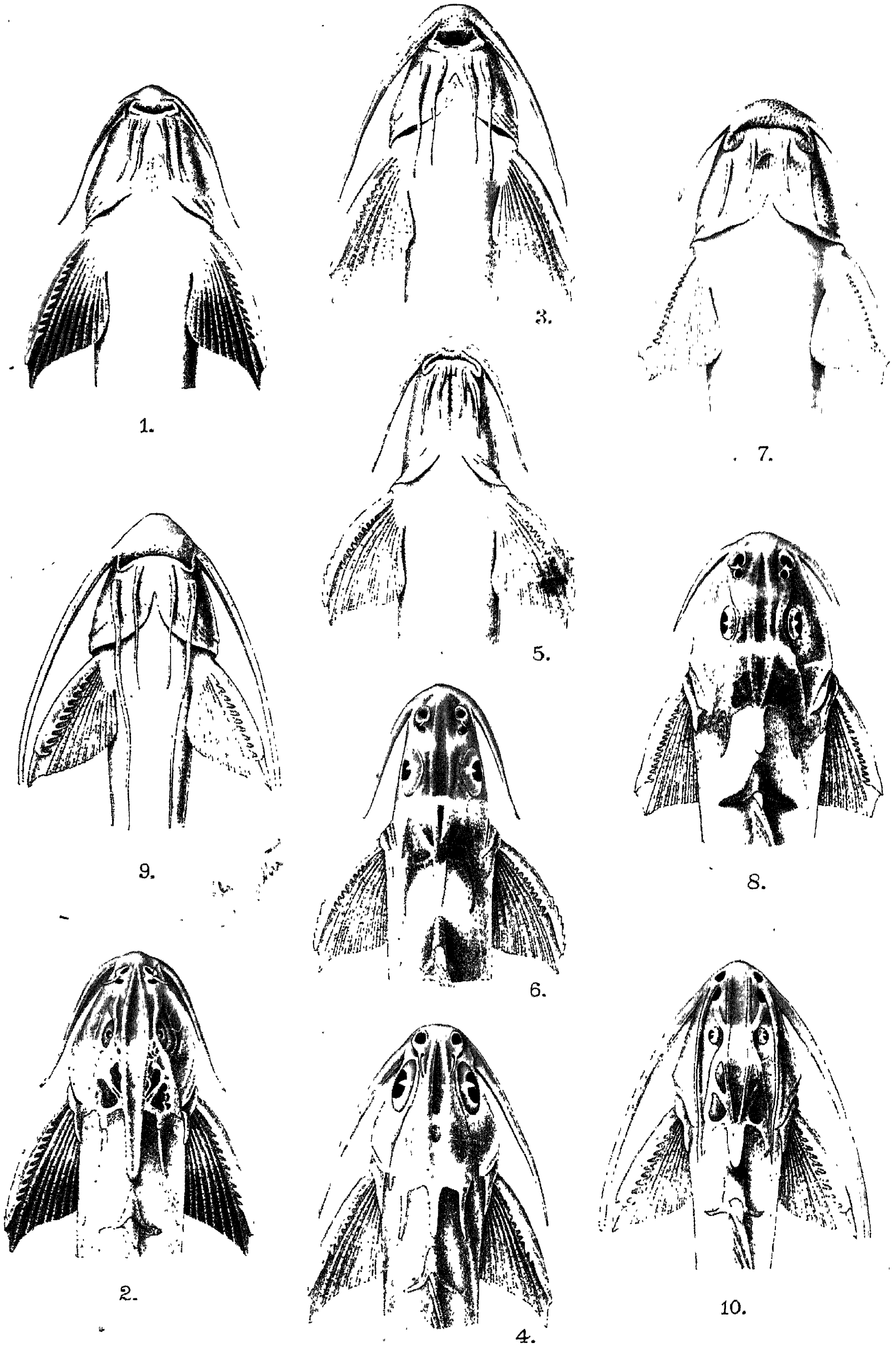
FIG. 5.—Ventral surface of head and anterior part of body. $\times 1\frac{1}{2}$.
FIG. 6.—Dorsal surface of head and anterior part of body. $\times 1\frac{1}{2}$.

Gagata viridescens (Hamilton).

FIG. 7.—Ventral surface of head and anterior part of body. $\times \frac{5}{6}$.
FIG. 8.—Dorsal surface of head and anterior part of body. $\times \frac{5}{6}$.

Gagata nangra (Hamilton).

FIG. 9.—Ventral surface of head and anterior part of body. $\times 3$.
FIG. 10.—Dorsal surface of head and anterior part of body. $\times 3$.



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Indian species of

EXPLANATION OF PLATE II.

Indian species of *Batasio* Blyth.

Batasio tengana (Hamilton).

FIG. 1.—Lateral view of a specimen from Duars, Eastern Himalayas. $\times 1\frac{1}{3}$.

FIG. 2.—Ventral surface of head and anterior part of body of same. $\times 1\frac{2}{3}$.

FIG. 3.—Dorsal surface of head and anterior part of body of same. $\times 1\frac{2}{3}$.

Batasio batasio (Hamilton).

FIG. 4.—Lateral view of a specimen from Duars, Eastern Himalayas. $\times 1\frac{1}{3}$.

FIG. 5.—Ventral surface of head and anterior part of body of same. $\times 2$.

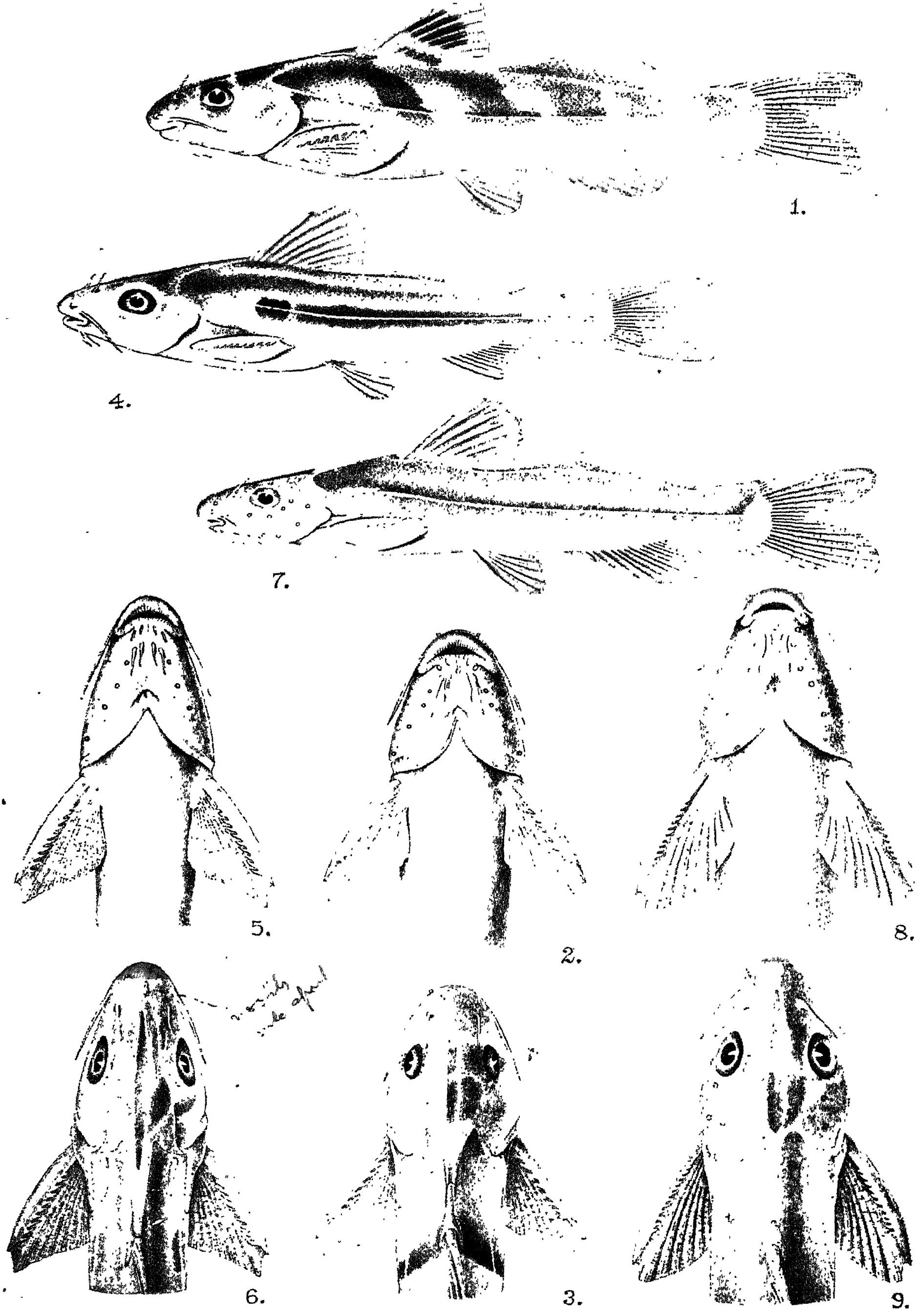
FIG. 6.—Dorsal surface of head and anterior part of body of same. $\times 2$.

Batasio travancoria, sp. nov.

FIG. 7.—Lateral view of type-specimen. *Nat. Size.*

FIG. 8.—Ventral surface of head and anterior part of body of same. $\times 1\frac{2}{3}$.

FIG. 9.—Dorsal surface of head and anterior part of body of same. $\times 1\frac{2}{3}$.



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On a small collection of fish from Perak, Federated Malay States

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In October 1938, I received from the Raffles Museum Singapore, a few specimens of fish "caught in a hill stream a 1000–2000′ in Perak, F.M.S.". I am very grateful to the Directo of the Raffles Museum for affording me an opportunity reporting on this small but extremely interesting materia'

From the labels accompanying the material it appea the fish were collected from the Plus River at Jalong, Perak, i August, 1938. The following four species are represented i the material examined by me:

Homalopteridæ

1. *Homaloptera wassinkii* Bleeker — 1 specimen.
2. *Homaloptera zollingeri* Bleeker — 3 specimens.

Amblycepidæ

3. *Amblyceps mangois* (Hamilton) — 10 specimens.

Akysidæ

4. *Acrochordonichthys rugosus* (Bleeker) — 6 specimens.

With the exception of *Homaloptera wassinkii*, which was doubtfully recorded by Duncker[1] from Kuala Lumpur in 1904, the remaining three species are recorded here from the Malay Peninsula for the first time. *Amblyceps mangois* was known hitherto from India, North Burma and Siam; *Homaloptera zollingeri* from Siam, Sumatra and Java; *Acrochordonichthys rugosus* and *Homaloptera wassinkii* from Sumatra, Java and Borneo. The new records of the above named Indo-Malayan species indicate that the Malay Peninsula served as the route of migration of the Oriental fauna from the north to the islands of the Malay Archipelago.

Homaloptera wassinkii Bleeker. (Plate I, figs. 1, 2)

1904. *Homaloptera* (sp. aff. ?) *wassinkii*, Duncker, *Mitt. Naturh. Mus. Hamburg*, XXI, p. 175, 1903.
1916. *Homaloptera wassinki*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 9.
1932. *Homaloptera wassinki*, Hora, *Mem. Ind. Mus.*, XII, p. 279.
1938. *Homaloptera wassinkii*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 55.

1. Duncker, G.—'Die Fische der malayischen Halbinsel'. *Mitt. Naturh. Mus. Hamburg*, XXI, p. 175 (1904).

Homaloptera wassinkii is the only Homalopterid species that has been known hitherto from the Malay Peninsula[1]; in 1904 it was doubtfully recorded by Duncker from Kuala Lumpur. Two young specimens of the species from Kuala Lumpur in the collection of the Amsterdam Museum were commented upon by me, but owing to their juvenile nature I was not certain of their correct determination. The specimen under report is 56 mm. in total length and agrees fairly closely with the description of the species by Weber and de Beaufort. The number of perforated scales along the lateral line is 41, and there is a well developed fleshy appendage in the axil of the pelvic fin. The scales on the ventral surface between the pelvic fins are embedded in skin and cannot be distinguished readily. In front of this region the ventral surface is totally devoid of scales. There are also certain differences in the proportions of the various parts and in order to facilitate reference in future I give below the measurements of the specimen from Perak.

Measurements in millimetres

Total length ..	56·0
Length of caudal	9·7
Depth of body ..	7·0
Length of head	10·8
Height of head at occiput	5·2
Width of head ..	8·6
Length of snout[2]	5·4
Diameter of eye	2·5
Interorbital width	3·8
Length of pectoral	14·7
Length of ventral	11·3
Longest ray of dorsal	8·8
Longest ray of anal	7·5
Length of caudal peduncle	6·8
Least height of caudal peduncle	4·2

Homaloptera wassinkii is known from Borneo, Java, Sumatra and the Malay Peninsula.

Homaloptera zollingeri Bleeker

1916. *Homaloptera zollingeri,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* III, p. 14.

1932. *Homaloptera zollingeri,* Hora, *Mem. Ind. Mus.,* XII, p. 280.

There are three specimens of *Homaloptera zollingeri* from Perak; they range in total length from 67 mm. to 90 mm. As

1. Since this article was written, Herre has described *Homaloptera tweediei* from the Mawai District, Johore (*Bull. Raffles Mus. Singapore,* No. 16, p. 7, 1940). I have referred to this species in my account of the loaches of the family Homalopteridae (*Bull. Raffles Mus. Singapore,* No. 17, p. 60, 1941).

2. Weber and de Beaufort's statement that the eye is "about thrice in snout" is obviously incorrect, for the eye is stated to be contained from 4·5 to 6 times in the length of the head; 'thrice' is probably a misprint for 'twice'.

pointed out by Günther[1], the upper lobe of the caudal fin is whitish in all the three specimens. The remaining fins are marked with dusky patches. The body is marked with a number of broad obscure bands. In some of the anteriormost dorsal scales subsidiary keels are faintly developed. The body is considerably more flattened and the snout more pointed in younger specimens.

Homaloptera zollingeri has been known hitherto from Siam, Sumatra and Java and it is here recorded from the Malay Peninsula for the first time.

The following table of measurements indicates differences in relative proportions between a half-grown and an adult specimen.

Measurements in millimetres

Total length	68·9	90·0
Length of caudal	14·0	17·5
Depth of body	7·3	11·4
Length of head	11·7	14·3
Width of head	9·3	13·3
Height of head at occiput	4·8	7·3
Diameter of eye	2·6	3·0
Length of snout	5·5	8·3
Interorbital distance	3·7	4·8
Longest ray of dorsal	9·0	12·4
Longest ray of anal	8·2	9·5
Length of pectoral	12·4	15·0
Length of pelvic ..	11·0	14·0
Length of caudal peduncle	11·6	13·0
Least height of caudal peduncle	3·7	5·8

Amblyceps mangois (Hamilton). (Plate I, fig. 3)

1933. *Amblyceps mangois*, Hora, *Rec. Ind. Mus.*, XXXV, pp. 607–621, text-figs. 1–7.

Amblyceps mangois is represented by 10 specimens in the collection; these range from 57 mm. to 100 mm. in standard length. They agree very closely with the Siamese specimens (Hora, *loc. cit.*, pp. 619–621) in almost all respects. The caudal fin is deeply forked in all examples and both the lobes are pointed; in some specimens the outer rays of the caudal fin are produced into long filamentous structures. The adipose fin is long and low; the anal fin is provided with about 13 rays; the barbels are relatively longer, the nasal barbels almost reach the base of the dorsal fin and all parts of the body are covered with small rounded tubercles. The special respiratory structures associated with the gill-openings are well developed.

Amblyceps mangois is found in rapid-running streams at the bases of hills. Up till recently it was known from the Himalayas, Northern Burma and Siam, but recently its range

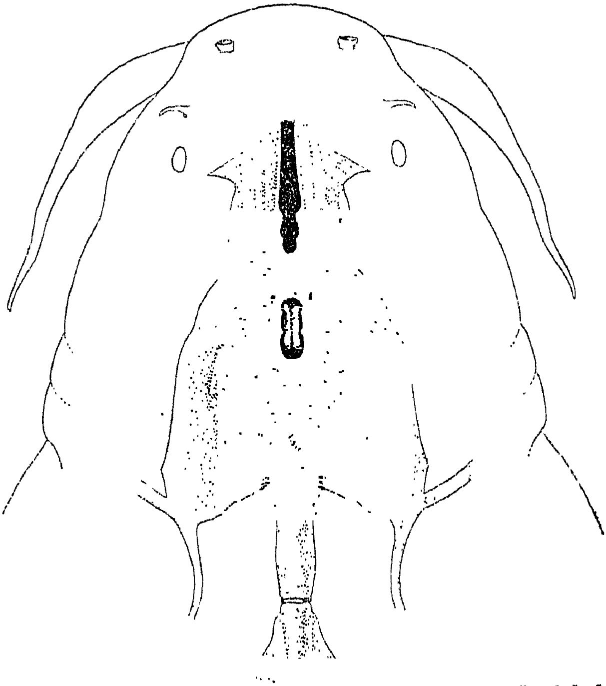
1. Günther, A.—*Catalogue of the Fishes in the British Museum*, VII, p. 342 (London: 1868).

was extended to the Rajmahal Hills[1] to the west of the Ganges. The species is here recorded from the Malay Peninsula for the first time. The occurrence of *Amblyceps* at Perak is of very great interest from a zoogeographical point of view and is likely to throw considerable light on the dispersal of the oriental freshwater fauna. Its presence in suitable localities in the intermediate regions can now be looked for with confidence.

Acrochordonichthys rugosus (Bleeker). (Plate I, fig. 4)

1913. *Acrochordonichthys rugosus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 368.

Acrochordonichthys rugosus is represented by 6 specimens in the collection from Perak; they vary in total length from 58



Text-fig. 1.—Dorsal surface of head of *Acrochordonichthys rugosus* (Bleeker) with a part of the skin removed to show the form of the occipital process, the position of the fontanels and the associated parts of skull. × 3.

mm. to 99 mm. The entire skin is granular and specially the portion covering the dorsal surface of the head appears like

1. Hora, S. L.—Notes on Fishes in the Indian Museum, XXXVI. On a Collection of Fish from the Rajmahal Hills, Santal Parganas, Bihar. *Rec. Ind. Mus.*, XL, p. 178 (1938).

the skin of a lizard (pl. i, fig. 4). The body is covered with a number of longitudinal rows of tubercles which are fewer in smaller specimens. In the smallest example there are only 4 rows of tubercles, while in the longest specimen there are 6 rows, though the uppermost and lowermost rows are not so extensive as the other ones. The barbels are small but they vary in length; the nasal barbels are always longer than the diameter of eye, the maxillary barbels may or may not extend to the gill-openings, the mandibular barbels may or may not reach the bases of the pectoral fins, while the mental barbels may be equal to or somewhat shorter than the length of the snout. Generally speaking, the barbels are longer in younger individuals. The occipital process is long and narrow; it touches the basal bone of the dorsal fin and is provided with a small oval hollow at its base which is distinctly separated from the large median fontanel. Laterally on each side of the hollow at the base of the occipital process there is a deep groove running forwards and outwards. The pelvics extend beyond the anal opening but do not reach the base of the anal fin. The caudal fin is very slightly emarginate with lobes broadly rounded; the upper lobe is slightly longer than the lower. The alimentary canal is short and the food consists mainly of insects and insect larvæ.

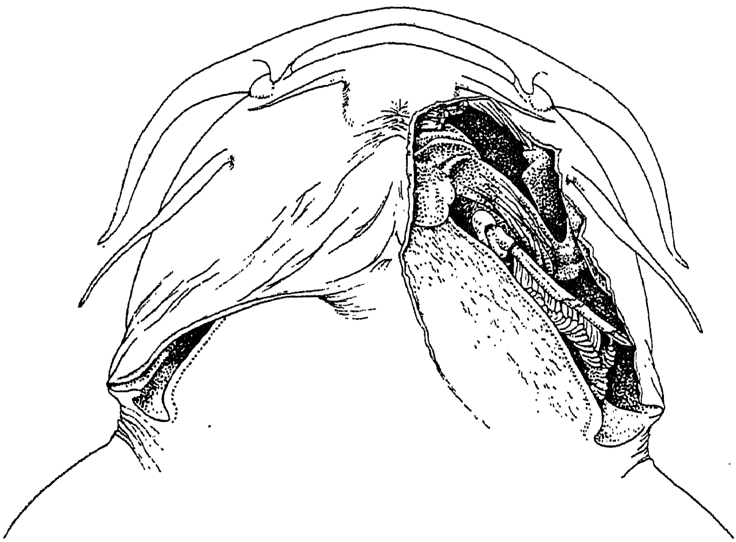
In the relative proportions of the various parts of the body the Malayan specimens show some variations from the description of the species by Weber and de Beaufort (*loc. cit.*). To facilitate future reference I give below measurements of two specimens from Perak.

Measurements in millimetres

Total length	99·0	81·7
Length of caudal	15·6	13·8
Height of body	16·2	13·0
Length of head	20·5	16·7
Height of head at occiput	13·6	10·3
Width of head	22·7	17·3
Length of snout	6·2	5·8
Interorbital width	8·3	6·0
Length of dorsal spine	13·7	10·8
Longest ray of dorsal	15·4	13·5
Longest ray of anal	12·0	10·8
Length of pectoral spine	17·3	13·3
Length of pectoral	19·7	15·8
Length of pelvic	10·8	8·6
Length of caudal peduncle	17·6	17·0
Least height of caudal peduncle ..	5·3	4·0

All the specimens are uniformly black in colour. The distal portions of all the fins, except the adipose dorsal, and the barbels are tipped with white. In some specimens the pelvic and anal fins are provided with irregular white patches.

One of the remarkable features of *Acrochordonichthys* is the restriction of its gill-openings[1] to the portions opposite to and below the bases of the pectoral fins. In *Acrochordonichthys* the gill-openings are fairly extensive, their membranes being united with each other and with the isthmus in the midventral line. But in spite of this the functional part of each opening appears to be limited to a spout-like portion immediately below the base of the pectoral fin. A membranous structure is



Text-fig. 2.—Ventral surface of head of *Acrochordonichthys rugosus* (Bleeker) with the gill-cover removed from the left side to show the membrane-like growth along the inner margin of the gill-cavity terminating in a spout-like structure for respiratory purposes. On the right side the gill-cover is slightly lifted to show the position of the spout-like structure. × 3.

developed along the inner margin of the gill-cavity so that, when in opposition to the gill-cover, it can stop the flow of water through the portion of the gill-opening co-extensive with it. Towards the posterior end and in the portion immediately below the base of the pectoral fin, however, the membrane is modified into a spout-like structure, presumably to provide a passage for expiratory current. In the uppermost portion of the gill-opening the gill-membrane is turned inwards and interlocks with the

1. It may be noted that as a rule, in hill-stream fishes the gill-openings, when reduced, as in certain Homalopterid and Sisorid fishes, are restricted to the dorsal surface of the head.

4.

Fish from Perak, Federated Malay States.

R. Bagchi del

membrane referred to above so as to prevent the water from flowing out in the portion above the spout. So far as I am aware a respiratory mechanism of this nature has not been described in any other fish.

Explanation of Plate I

Fig. 1. -Lateral view of a specimen of *Homaloptera wassinkii* Bleeker from Perak. $\times 2\,{}^{3}/_{16}$.
The lepidosis as shown in the figure is somewhat inaccurate.

Fig. 2.—Ventral view of same. $\times 2\,{}^{3}/_{16}$.

Fig. 3.—Lateral view of a specimen of *Amblyceps mangois* (Ham.) from Perak. $\times 1\,{}^{5}/_{16}$.

Fig. 4.—Dorsal surface of head and anterior part of body of *Acrochordonichthys rugosus* (Bleeker) to show the nature of the skin. $\times 1\tfrac{3}{4}$.

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Family

The family Siluridæ is represented by seven genera, comprising thirteen species, in the fauna of the Malay Peninsula. Of the 13 species, 4 are recorded here for the first time from this region and one is described as new.

The family Siluridæ is characterised by the possession of a very short, spineless dorsal, which is sometimes rudimentary or absent. We have found it rather difficult to use the key to the genera of the Siluridæ given by Weber and de Beaufort[1], in which the main divisions are based on the nature of the dorsal fin. The Malayan genera may, however, be distinguished by the following key:—

Key to the Malayan genera of Siluridæ

A. Eyes with free orbital margins. [Eyes above angle of mouth]	*Wallagonia* Myers.
B. Eyes subcutaneous—	
I. Teeth long and widely set. [Eyes above angle of mouth]	*Wallago* Bleeker.
II. Teeth villiform forming bands—	
a. Caudal broadly confluent with anal. [Eyes above angle of mouth] ..	*Silurichthys* Bleeker.
b. Caudal free from or slightly united with anal—	
i. Eyes mostly above angle of mouth; generally not visible from below—	
α. Cleft of mouth not extending beyond front border of eyes; dorsal fin well-defined with at least 4 rays	*Callichrous* Hamilton.
β. Cleft of mouth extending beyond front border of eye; dorsal fin rudimentary or absent ..	*Silurus* Linnaeus.
ii. Eyes lateral, partly below angle of mouth; generally visible from below—	
α. Dorsal short, but well-defined, with at least 3–4 rays	*Silurodes* Bleeker.
β. Dorsal rudimentary or absent; when present, consisting of 1–2 rays ..	*Kryptopterus* Bleeker.

1. Weber, M. and de Beaufort, L. F.—*The Fishes of the Indo-Australian Archipelago*, II, p. 195 (Leiden: 1913).

Of the genera enumerated above, we have not examined any specimen of *Wallago*[1] (=*Belodontichthys* Bleeker) from this region; it is a monotypic genus known from Sumatra, Borneo, Malaya and Siam. From the Malay Peninsula it has been recorded from Kuala Lipis, Pahang and Mr. M. W. F. Tweedie, Curator of the Raffles Museum, informs us that he recently collected a specimen at Kuala Tahan, Pahang.

From among the Silurid fishes known from this region, we have not examined any specimens of the following: *Kryptopterus micronema* (Bleeker) recorded by Herre and Myers[2] from several localities in the Malay Peninsula, *Kryptopterus cryptopterus* (Bleeker) stated to have been collected at Kampong Johore[3] and *Callichrous leiacanthus* Bleeker recorded by Herre[4] from Singapore. Notes on the remaining ten species studied by us are given below.

Callichrous bimaculatus (Bloch)

1913. *Callichrous bimaculatus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 209.

1936. *Callichrous pabda*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.

1937. *Ompok bimaculatus*, Herre and Myers, *ibid.*, No. 13, p. 67.

1938. *Ompok pabda*, Fowler, *Fisheries Bull. Singapore*, No. 1, pp. 45, 248.

Callichrous bimaculatus is the most widely distributed species of the genus; its range extends from Java, Sumatra, Borneo through the Malay Peninsula to Siam, Burma, Chusan, Yunnan, India and Ceylon. We have examined 7 specimens from Singapore, Kelantan, Perlis and Pahang; they vary in length from 96 mm. to 205 mm. In certain specimens, the anterior border of the eye is somewhat behind the corner of the outh, otherwise all the specimens agree with the examples from ia.

One of us[5] has shown that the generic designation *Callic* is quite valid and has adduced evidence to show that *C. pabda*

Ansorgia, Clarisilurus, Wallag an and Indo-Malayan Catfishes.

. S.—A contribution to the Ichthyo- Freshwater Fishes. *Bull. Raffles* *ingapore*, No. 13, p. 67 (1937).

3. Fowler, H. W.—A List of the Fishes known from Malaya. *Fisheries Bull. Singapore*, No. 1, p. 46 (1938).

4. Herre, W. C. T.—Additions to the Fish Fauna of Malaya and Notes on rare or little known Malayan and Bornean Fishes. *Bull. Raffles* No. 16, p. 35 (1940).

5. Hora, S. L.—Siluroid Fishes of India, Burma and Ceylon. VIII. Fishes of the genus *Callichrous* Hamilton. *Rec.* ., XXXVIII, pp. 356–361 (1936).

is synonymous with *C. bimaculatus*. The differences which separate the two species are of the nature of individual variations.

Kryptopterus bicirrhis (Cuvier & Valenciennes)

1913. *Cryptopterus bicirrhis*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 217.

We have examined two specimens of *Kryptopterus bicirrhis* collected by Mr. E. O. Shebbeare from the King George V National Park in 1939; they are 120 mm. and 146 mm. in length respectively. In both the specimens the dorsal fin is composed of two rays instead of one. The mandibular barbels are absent in the larger specimen, while in the other they are very rudimentary.

K. bicirrhis has hitherto been known from Java, Sumatra, Borneo and Siam. Its occurrence in the Malay Peninsula, which is recorded here for the first time, helps to bridge the gap in its distribution.

Kryptopterus limpok (Bleeker)

1913. *Cryptopterus limpok*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 219.
1936. *Cryptopterus limpok*, Suvatti, *Index Fishes Siam*, p. 71.

We refer a specimen from Sungai Bera, Pahang, collected by Mr. H. J. Kitchener in 1937, to *Kryptopterus limpok;* it is about 160 mm. in length. It differs from Weber and de Beaufort's description of the species in having somewhat smaller eyes (diameter of eye is contained 4 times in length of head instead of 3, and 1·5 times in length of snout instead of equal to snout).

K. limpok has hitherto been known from Sumatra, Borneo and Siam. It is recorded here for the first time from the Malay Peninsula.

Kryptopterus macrocephalus (Bleeker)

1913. *Cryptopterus macrocephalus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 217.
1937. *Kryptopterus macrocephalus*, Herre and Myers, *Bull. Raffles Mus. Singapore*, No. 13, p. 67.
1940. *Kryptopterus macrocephalus*, Herre, *ibid.*, No. 16, p. 35.

Herre and Myers recorded *Kryptopterus macrocephalus* for the first time from the Malay Peninsula (Bukit Merah, Perak); they had a single specimen, 66 mm. long. Later Herre recorded the species from Kota Tinggi, Johore. We have examined 3 specimens; two from Kota Tinggi, Johore, 64 and 73 mm. in length respectively and one from Bukit Merah, Perak, about 77 mm. in length. It would thus appear that the species is not uncommon in the Malayan Waters.

K. macrocephalus is now known from Sumatra, Borneo and the Malay Peninsula.

Silurichthys phaiosoma (Bleeker)

1913. *Silurichthys phaiosoma*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 197.
1936. *Silurichthys phaiosoma*, Suvatti, *Index Fishes Siam*, p. 72.
1936. *Silurichthys phaiosoma*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1937. *Silurichthys phaiosoma*, Herre and Myers, *ibid.*, No. 13, p. 66.
1938. *Silurichthys phaiosoma*, Fowler, *Fisheries Bull. Singapore*, No. 1, pp. 46, 248.

We have examined two specimens of *Silurichthys phaiosoma* from Johore and Singapore; they are 98 mm. and 114 mm. in total length respectively. The species has been recorded from several other localities in the Malay Peninsula and its range extends from Sumatra, Banka, Biliton, Borneo, Malay Peninsula to Siam.

Silurichthys schneideri Volz. (Plate II, fig. 1)

1913. *Silurichthys schneideri*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 198.

Weber and de Beaufort regarded *Silurichthys schneideri* as a doubtful species, and stated that "The only differences from *S. phaiosoma* seem to be: A. 64 instead of A. 53–58 and that the gape of mouth only reaches below front border of eye and not to its middle." Weber and de Beaufort did not examine any specimen of this species, and relied for their description on the account given by Volz[1]. We have examined specimens of both the species referred to above and find that, though they are very closely allied, the differences noted above are constant and enable them to be distinguished from each other.

We have examined 5 specimens of *S. schneideri* from Jalong, Perak; ranging in length from 117 mm. to 178 mm. Four of these specimens are of a somewhat slender build, and in them the height of the body is contained from 2 to 2½ times (instead of 1½) in the distance between the tip of the snout and the commencement of the anal fin. In other respects, the Malayan specimens agree with Volz's description of the species.

S. schneideri has hitherto been known only from Sumatra; it is recorded here for the first time from the Malay Peninsula.

Silurodes hypophthalmus (Bleeker)

1913. *Silurodes hypophthalmus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 205.
1936. *Silurodes hypophthalmus*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1937. *Silurodes hypophthalmus*, Herre and Myers, *ibid.*, No. 13, p. 67.
1938. *Silurodes hypophthalmus*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 248.

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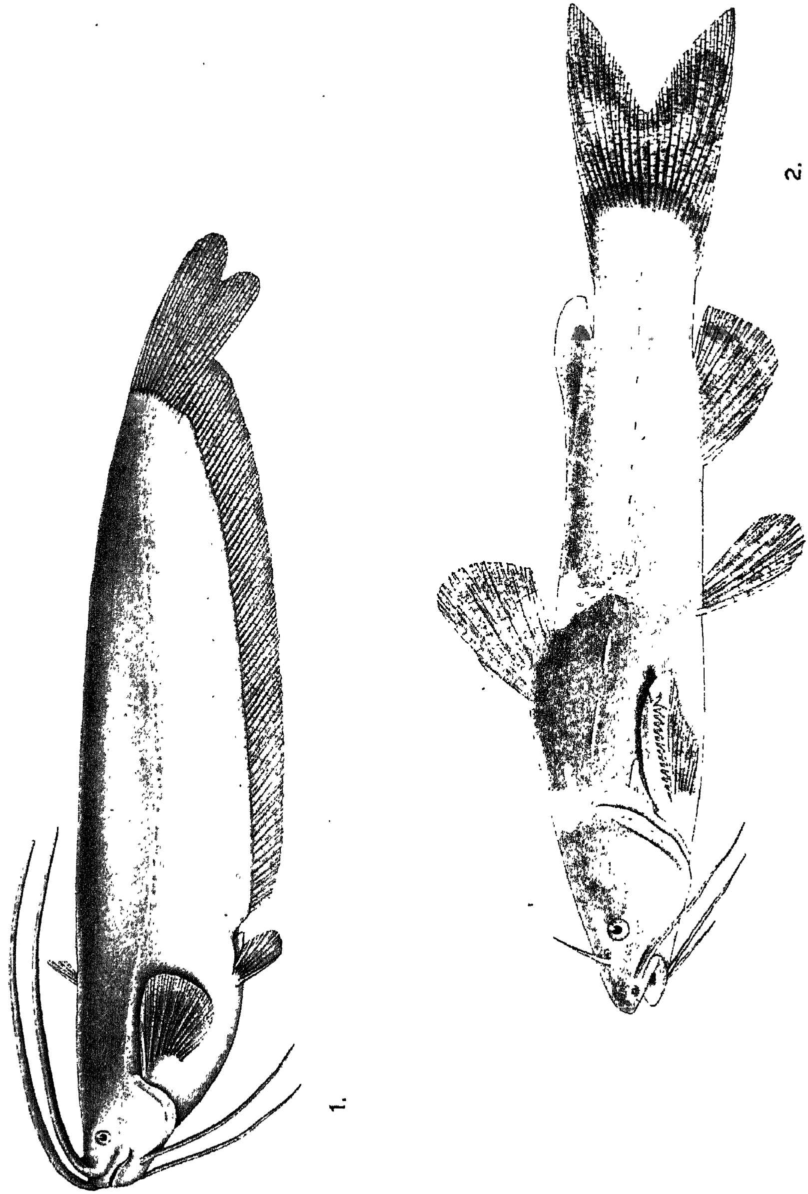
1. Volz, W.—**Fische von Sumatra gesammelt von Herrn G. Schneider.** *Revue Suisse Zool.*, XII, p. 463 (1904).



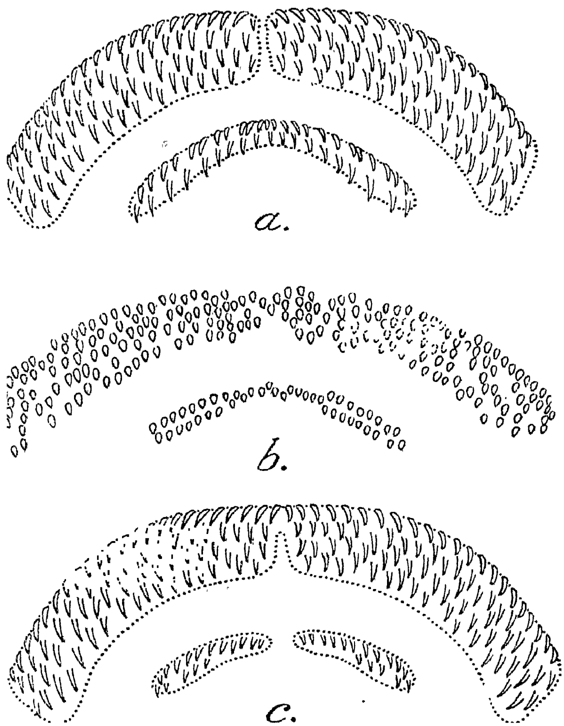
1.

2.

Siluroid Fishes from the Malay Peninsula.

A. K. Mondul del.

We have examined two specimens of *Silurodes hypophthal-* rom Pahang (195 mm. in total length) and Perak (180 mm. in standard length). According to Weber and de Beaufort, the vomerine teeth in this genus form a single continuous patch, but we have found that in the example from Pahang the vomerine dentition is greatly reduced and the teeth are arranged in two patches separated by a short space. On the other hand, in the specimen from Perak the continuous vomerine patch is well-developed and possesses two rows of teeth throughout its



Text-fig. 1.—Upper dentition of three specimens of *Silurodes hypophthalmus* (Bleeker) showing variation in the form of the vomerine patches.
a. From a specimen collected in Perak. × 4½; *b.* After Weber and de Beaufort (vol. II, fig. 81); *c.* From a specimen collected in Pahang. × 4½.

extent. The condition figured by Weber and de Beaufort (text-fig. 81, p. 206) is intermediate between the two types of dentition represented in the Malayan specimens studied by us. In our opinion the differences in dentition noted above are not even of

specific importance[1] though Weber and de Beaufort have used this character to separate *Callichrous* from *Silurodes*. In all other respects the two specimens agree with the description of the species as given by Weber and de Beaufort.

S. hypophthalmus is found in Java, Sumatra, Borneo, Malay Peninsula and Siam.

Silurus cochinchinensis Cuvier & Valenciennes.

1936. *Silurus cochinchinensis*, Hora, *Rec. Ind. Mus.* XXXVIII, pp. 351–356.

Silurus cochinchinensis is represented by a single specimen, 109 mm. in length; it was obtained from Baling, Kedah in December, 1938. This species has hitherto been found in Cochin-China, Upper and Lower Burma, and the Eastern Himalayas up to the Tista River System. It is here recorded for the first time from the Malay Peninsula.

Hora (*loc. cit.*) separated the two Indian species of the genus, *S. wynaadensis* Day and *S. cochinchinensis* Cuv. & Val., on the number of mandibular barbels—4 in the former and 2 in the latter. Recently Prof. A. Subba Rau and Mr. B. S. Bhimachar[2] found considerable variation in the number of mandibular barbels in the specimens of *Silurus* collected by them in the Mysore State, and their conclusion, which Hora supports, is that the two Indian species are identical. Their findings extend the range of *S. cochinchinensis* to Peninsular India.

Wallagonia leerii (Bleeker)

1913. *Wallago leerii*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 202.
1936. *Wallago leeri*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1938. *Wallago leerii*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 248.
1938. *Wallagonia leerii*, Myers, *Copeia*, No. 2, p. 98.

Myers in establishing his genus *Wallagonia* designated *W. leerii* as the genotype. We have examined one specimen, 250 mm. in length, collected at Telok Anson, Perak. The range of distribution of the species extends to Sumatra, Banka and Borneo.

Wallagonia tweediei, sp. nov., Hora & Misra[3].

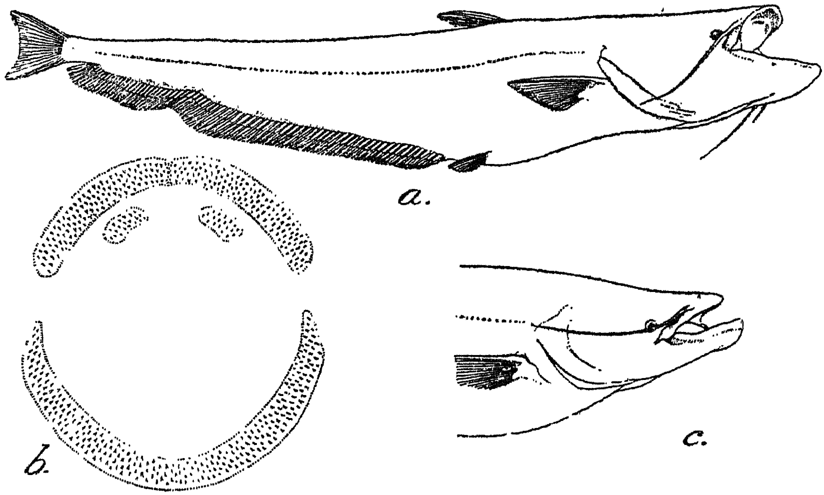
In May, 1940, Mr. Tweedie sent the right anterior gill arch of a giant Silurid fish collected by him at Kuala Tahan, Pahang,

1. *See* Hora's notes on the dentition of *Clarias* and *Silurus* in *Rec. Ind. Mus.* XXXVIII, pp. 347–356 (1936).

2. The paper, in which Prof. A. Subba Rau and Mr. B. S. Bhimachar discuss the systematic position of *S. wynaadensis* is not yet published, but one of us (S. L. H.) had an opportunity to see the type-script and the specimens.

3. Mr. K. S. Misra very kindly helped me in elucidating the relationships of the new species which is now jointly described by us. *S. L. Hora.*

and supplemented it with photographs and notes in order to facilitate the identification of the species. A sketch of its dentition was also supplied. The specimen was too bulky to be



Text-fig. 2.—*Wallagonia tweediei*, sp. nov. Hora and Misra.
a. Lateral view of type-specimen; *b.* Upper and lower dentition; *c.* Lateral view of head and anterior part of body showing position of eye in relation to angle of mouth. All diagrammatic.
The drawings were made from photographs, sketches and data supplied by Mr. M. W. F. Tweedie.

preserved *in toto*, so a plaster mould was taken and its fins and one gill arch were preserved. Mr. Tweedie's note is as follows:—

"Length: 4 ft. 9″ (with caudal).
Depth: (at dorsal) 1 ft.
Dorsal: 1.4.
Pectoral: 1.14.
Ventral: 1.7.
Anal: 70—the 43 anterior rays with a fleshy extension covering more than half their length and shortening suddenly at the 44th.

"Colour dark greyish brown with light longitudinal streaks; belly, back to ventrals, and underside of head white. The caudal is truncate, not forked. There is one pair of long maxillary and one pair of small mental barbels, each maxillary barbel being between 12 and 13 inches long."

In accordance with the data supplied by Mr. Tweedie, the fish was provisionally referred to the genus *Wallagonia* Myers in spite of its truncate caudal fin and short pelvic fins (with 8

instead of 10 to 11 rays). On an enquiry, the following further particulars were supplied by Mr. Tweedie:—

"The caudal fin is slightly emarginate, perhaps more so than the photo shows, as the tips of the rays were damaged by being dragged along the ground. On the other hand I asked the Malays at Kuala Tahan if the tail is normally forked in the 'Tapah' (they know the fish well) and they said 'no'.

"The anal and the caudal fins are positively not confluent.

"The anterior ray of the dorsal fin is unbranched, thick and stiff proximally, but becomes flexible distally, and so cannot be said to be a spine.

"The orbital margin is free and the eye is situated considerably above and slightly behind the angle of the mouth.

"Exact data regarding the number of the branchiostegal rays are not available; the head was cut off in front of the branchiostegals and I failed to count them. The plaster mould shows external indications of 8–9 and I should estimate the total number as 12–15."

In a subsequent letter, Mr. Tweedie[1] wrote as follows:—

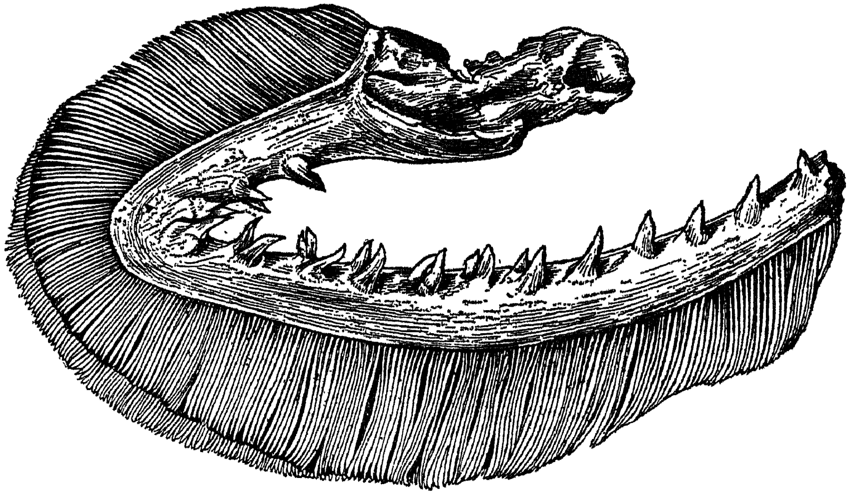
"Mr. Pendlebury of the Kuala Lumpur Museum has sent me the following observations on a stuffed specimen of the 'Ikan Tapah' they have there, provisionally determined as *Wallago leeri:* Pectoral, 14; Ventral, 9; Dorsal, 5; Caudal, 17; Anal, 72–74. Total length 1·1 metres. I have not been able to check these observations, but I should imagine that, if any are inaccurate it would be due to the small hinder rays of the fins being difficult to discern in a dry skin, and so the figures would be too low rather than too high."

Mr. E. O. Shebbeare also supplied particulars of an "Ikan Tapah", 3 ft. 8 inches in length, and noted V. 1/9. The caudal fin is stated to be bluntly lobed.

Owing to the larger number of rays in the pelvic fins of the specimen of 'Ikan Tapah' in the Kuala Lumpur Museum, and the one examined by Mr. E. O. Shebbeare it is probable that they belong to *Wallagonia leeri*. Besides the smaller number of rays in the pelvic fin, the new species differs from the other

1. Mr. M. W. F. Tweedie also directed our attention to F. G. Sounter's note entitled "A Formidable Fish from Malay" published on June 24, 1933, in *The Field* (The Country Newspaper). In this article the author gives a brief account of an "Ikan Tapah" caught by him in Perak and states that "It is called 'Ikan Tapah' by the Malays, and *Wallago Leerii* in the Selangor Museum, the curator of which tells me it is grouped with the freshwater sharks. It was 5 ft. 6 in. in length, 43 in. at its greatest girth, and weighed 102 lb. It was a hen fish, and a mass of ova was evidently discharged from the vent while the fight was on, as some was protruding when it was lifted into the boat, and small fish were making feeding rings close to it when it was pumped to the surface. Its weight when hooked was therefore probably more than that recorded out of the water." The author points out that the head of the fish is now preserved at the museum in Kuala Lumpur.

From the data given above, it is not possible to determine the fish specifically, but it could certainly be *Wallagonia leeri* (Bleeker), which is known to grow to a large size.



Text-fig. 3.—Right anterior gill-arch of *Wallagonia tweediei*, sp. nov. Hora and Misra, showing the number, disposition and nature of gill-rakers. × ⅔.

four members of this genus in having 3+12 gill-rakers, which are fairly well-developed, hard, conical and pointed. *Wallagonia krattensis* (Fowler)[1] also possesses 8 rays in the pelvic fin but its anal fin contains only 56 rays.

The vomerine teeth of *W. tweediei* consist of two small, widely set, rounded patches.

Type-specimen:—Plaster cast in the Raffles Museum, Singapore, and the right anterior gill-arch in the collection of the Zoological Survey of India, Indian Museum, Calcutta, (No. F. 13365/1).

Remarks:—*Wallagonia tweediei* is distinguished from its congeners mainly on the following two characters:—

1. The caudal fin is only slightly emarginate (*versus* forked).
2. Twelve gill-rakers (*versus* 21 or more in *W. attu*, 9 in *W. leeri*, *W. miostoma* and *W. krattensis*).

The new species of *Wallagonia* is named after Mr. M. W. F. Tweedie in slight recognition of the help received from him in the study of the Malayan fishes.

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1. Fowler, H. W.—Zoological Results of the Third De Schauensee Siamese Expedition, Part V. Additional Fishes. *Proc. Acad. Nat. Sci. Philadelphia* LXXXVI, p. 335, fig. 1 (1934).

Family BAGRIDÆ

The generalised catfishes of the family Bagridæ are represented by four genera, *viz.*, *Batasio* Blyth, *Mystus* Dumeril, *Leiocassis* Bleeker and *Pseudobagrus* Bleeker, in the fauna of the Malay Peninsula. Of these, the range of *Pseudobagrus* and *Batasio* does not extend to the Malay Archipelago, while the other two genera occur both to the north and south of the Malay Peninsula. It may be noted that identical species of *Bagroides* Bleeker, such as *B. melapterus* Blkr. and *B. macropterus* Blkr. are found in Sumatra and Borneo on the one hand and in Siam on the other. It is likely that some representatives of this genus will also be found from the Malay Peninsula. The four Malayan genera may be distinguished by the following key:—

Key to the Malayan genera of Bagridæ

A. Eyes with free or partially free orbital margins—	
I. Anal with less than 20 rays—	
a. Mouth ventral, bordered by fringed lips; barbels shorter than head. [Series of open pores on the ventral surface just behind the mouth] ..	*Batasio* Blyth.
b. Mouth terminal, bordered by plain lips; barbels longer than head	*Mystus* Dumeril.
II. Anal with more than 20 rays ..	*Pseudobagrus* Bleeker.
B. Eyes subcutaneous	*Leiocassis* Bleeker.

One species of *Pseudobagrus* was described by Duncker (*Naturh. Mus. Hamburg, Mitteil.*, XXI, p. 173, pl. ii, fig. 132, 1904) from the Muar River at Tubing Tinggi, but we have not examined any specimen of it. *Mystus* is represented by 9 species in the Malay Peninsula, but we have examined specimens of only 6. The other three species are *M. elongatus* (Günther) known from Singapore (*Cat. Fish. Brit. Mus.*, V, p. 77, 1864); *M. baramensis* (Regan), which was recently recorded by Herre and Myers from Lake Chin Chin, Jasin, Malacca, and *M. gulio* (Ham.), which is listed by Fowler (*loc. cit.*, p. 47) as *Aspidobagrus gulio* under the family Bagaridæ. Of *Leiocassis,* 5 species are known from the Malay Peninsula, of which we have not examined any specimens of *L. stenosomus* (Cuv. & Val.); this was recorded by Duncker (*loc. cit.*, p. 173) from Kuala Lumpur. Besides the two species of *Bagroides* mentioned above, *Leiocassis poecilopterus* (Cuv. & Val.) is also found in Java, Sumatra and Borneo on the one hand and Siam on the other, though it has not yet been recorded from the Malay Peninsula. Notes on 11 Bagrid species examined by us are given below. One species each of *Batasio, Mystus* and *Leiocassis* are recorded here for the first time from the Malay Peninsula.

Batasio tengana (Hamilton). (Plate IV, fig. 7).

1822. *Pimelodus tengana*, Hamilton, *Fish. Ganges*, pp. 176, 377, pl. xxxix, fig. 58.
1839. *Bagrus tengana*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* XIV, p. 433.
1854. *Bagrus tengana*, Bleeker, *Verh. Bat. Gen.* XXV, p. 56.
1860. *Batasio affinis*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 150.
1860. *Batasio tengana*, Blyth, *ibid.*, XXIX, p. 150.
1864. *Macrones affinis*, Günther, *Cat. Fish Brit. Mus.* V, p. 83.
1864. *Macrones tengana*, Günther, *ibid.*, V, p. 84.
1873. *Macrones affinis*, Day, *Proc. Zool. Soc. London*, p. 111.
1877. *Macrones Blythii*, Day, *Fish. India*, p. 445.
1877. *Gagata tengana*, Day, *ibid.*, p. 493.
1888. *Leiocassis fluviatilis*, Day, *Fish. India Suppl.*, p. 805.
1889. *Liocassis fluviatilis*, Day, *Faun. Brit. Ind. Fish.*, I, p. 164.
1889. *Macrones blythii*, Day, *ibid.*, I, p. 151.
1889. *Gagata tengana*, Day, *ibid.*, I, p. 210.
1890. *Macrones* Dayi, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 230, pl. vii, fig. 3.
1913. *Macrones marianiensis*, Chaudhuri, *Rec. Ind. Mus.* VIII, p. 253.
1921. *Macrones (Macronoides) affinis*, Hora, *ibid.*, XXII, p. 180.
1921. *Macrones (Macronoides) merianiensis*, Hora, *ibid.*, XXII, p. 736.
1937. *Leiocassis rama*, Shaw and Shebbeare (*nec* Hamilton), *Journ. Roy. As. Soc. Bengal, Science*, II, p. 90, text-fig. 88, pl. iii, fig. 4.

In the collection of the Raffles Museum there are six specimens, from 62 to 79 mm. in length, from the Chenderoh Lake, Perak, which seem to belong to *Batasio tengana.* The synonymy given above shows that great confusion has hitherto prevailed regarding the taxonomy of this species, but Hora and Law have recently elucidated its specific position in a revision of the fishes of the genus *Batasio* which will be published in the *Records of the Indian Museum* for 1941. The most characteristic feature of the species is its colouration which varies to a certain extent with age and locality.

In the examples from Perak the black blotch on the lateral line above the anal fin is very conspicuously marked, while the anterior blotch represents the area against which the air-bladder comes directly in contact with the skin. Another conspicuous feature of these examples is an oblique horseshoe-shaped band lying in front of the first dorsal fin and descending on the sides to below the lateral line. Sometimes this band breaks up into a dorsal blotch and two oblique bars on the sides. There is a submarginal band on the dorsal fin and the tips of the caudal fins are somewhat dusky but not black.

A detailed description of the species will be published by Hora and Law. So far the range of *B. tengana* was known to extend from the Eastern Himalayas, through Assam to Burma; it is here recorded from the Malay Peninsula for the first time.

Leiocassis baramensis Regan. (Plate IV, fig. 1)

1906. *Liocassis baramensis*, Regan, *Ann. Mag. Nat. Hist.*, (7), XVIII, p. 67.
1913. *Leiocassis baramensis*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 358.
1933. *Leiocassis chaseni*, de Beaufort, *Bull. Raffles Mus. Singapore*, No. 8, p. 34.
1936. *Leiocassis chaseni*, Tweedie, *ibid.*, No. 12, 19.
1938. *Leiocassis chaseni*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 249.

We have examined two specimens of *Leiocassis*, which, in our opinion, are referrable to *L. baramensis* Regan; one specimen, 150 mm. long, was collected by Mr. H. J. Kitchener at Sungai Lumpat, Pahang; while the other, 116 mm. long, was obtained from Jalong, Perak. After comparing these examples with the type of *L. chaseni*, Tweedie had referred them to that species, but a further study of these specimens has shown that the differences, which distinguish *L. chaseni* from *L. baramensis*, are not of specific value.

In his description of *L. chaseni*, de Beaufort stated that:

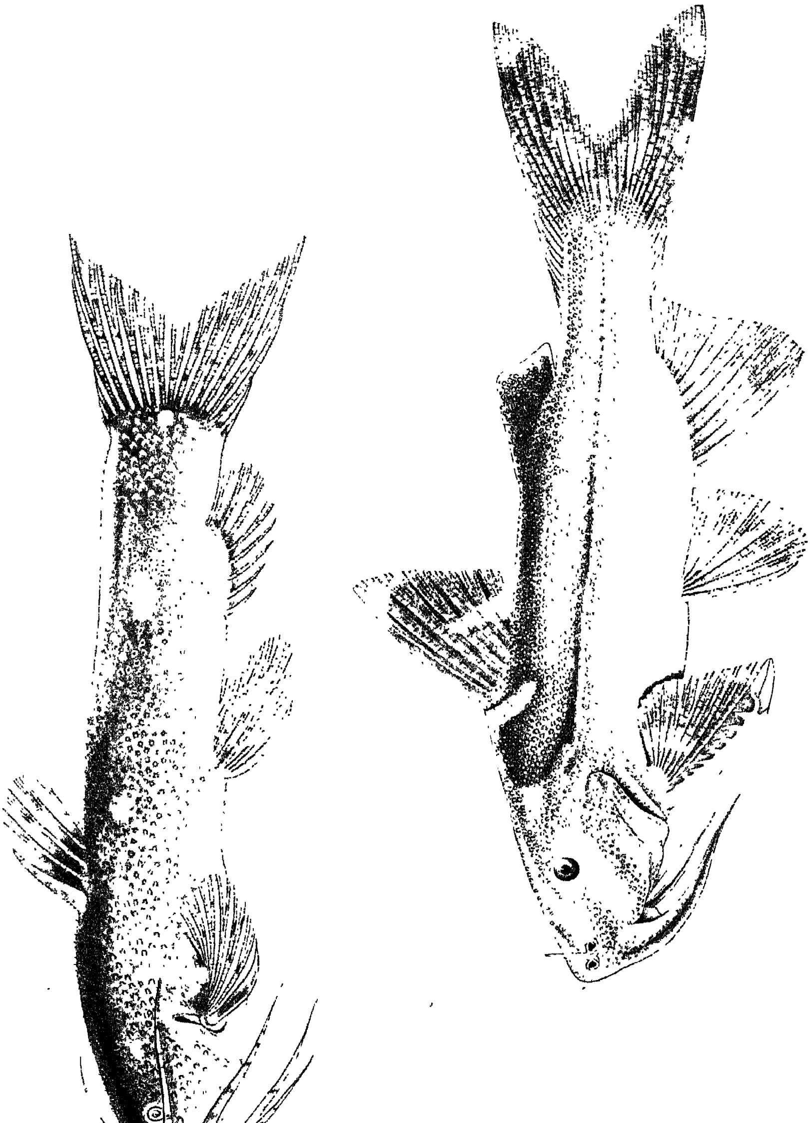
> "This species comes nearest to *L. baramensis* Reg. from Borneo, differing by its longer dorsal and pectoral spines, *baramensis* having less serrae. The eye is probably larger, but the difference may be due to the difference in size of the two type-specimens, that of Regan being 190 mm."

L. chaseni was described from a single specimen, 85 mm. in length with the caudal fin broken.

The differences between the two species noted above may now be analysed with the help of the specimens under report.

The dorsal spine of *L. baramensis* is stated to be "feebly serrated behind, ½ the length of head"; that of *L. chaseni* is "strong, with about 8 serræ posteriorly, as long as head without snout". In the specimens examined by us the spine is strong, feebly serrated with about 10–12 serræ and almost as long as head without snout which is more than half the length of the head.

The pectoral spine of *L. baramensis* is "a little more than ½ the length of head, with 23 serræ on its inner edge"; that of *L. chaseni* is "strong, serrated along its inner edge, as long as dorsal spine". In the specimens before us the spine is strong, somewhat shorter than the dorsal spine (still longer than half the length of the head) and is pectinated along the inner border with 15 to 17 serræ.



Siluroid Fishes from the Malay Peninsula.

B. N. Bagchi & A. K. Mondul del.

In *L. baramensis* "Diameter of eye 9 in the length of head"; in *L. chaseni* "Eye 3·7, less than twice in snout, 1·4 in interorbital space". In the two specimens under report, the diameter of the eye is contained from 6·5—7·0 times in the length of the head, and more than twice in the length of the snout and the interorbital space. It is well recognised that in young specimens the eyes are proportionately larger, but "3·7" in de Beaufort's description is certainly a misprint for 5·7 or something else.

It will be seen from the above that the so-called distinguishing features of the two species are not of very great importance and are likely to be bridged over when further material becomes available for study from Borneo and the Malay Peninsula.

In colouration our specimens agree fairly closely with *L. baramensis*. According to Regan its colouration is as follows:—

> "Brownish, with 2 oblong pale areas on each side of the posterior part of the body above the lateral line, the second small and well separated from the first; similar pale areas below the lateral line are confluent, and the anterior meets that of the other side in front of the anal fin; fins more or less blackish at the base and with blackish intermarginal bands."

In the smaller of the two specimens examined by us the colour pattern is more brilliantly marked. In the illustration we have reproduced the colours of this example though the outline sketch was made from the larger specimen.

L. baramensis is known from Borneó (Baram River) and the Malay Peninsula (Ulu Jelai and Sungai Lumpat, Pahang; Jalong, Perak).

Leiocassis fuscus Popta. (Plate II, fig. 2)

1913. *Leiocassis fuscus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 353.

1940. *Leiocassis bicolor*, Herre (*nec* Fowler), *Bull. Raffles Mus.*, 16, p. 36.

Leiocassis fuscus has hitherto been known from a single specimen, 51 mm. long, which was obtained from the Upper Mahakam River, Borneo. There is a small specimen, 44 mm. long, collected from a swift stream in the Mawai District, Johore, which, in our opinion, is referrable to this species. The Malayan example is more slender and depressed; the height of its head being contained twice in its length instead of $1\frac{2}{3}$, and the height of its body is contained 7 times in the total length and 6 times in the length without the caudal. Accordingly, the height of the dorsal fin is more or less equal to the depth of the body. The dorsal spine and the adipose fin are somewhat longer. There are also other minor differences in proportions, but all of them seem to be of the nature of individual variations.

Leiocassis leiacanthus Weber & de Beaufort

1913. *Leiocassis leiacanthus,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 364.
1937. *Leiocassis leiacanthus,* Herre and Myers, *Bull. Raffles Mus. Singapore,* No. 13, p. 69.

Leiocassis leiacanthus is represented by a single specimen in the collection; it is 59 mm. in length and was obtained from the river Plus in Perak. Herre collected a specimen of this species from the Mawai District, Johore.

L. leicanthus is so far known to occur in Sumatra and the Malay Peninsula.

Leiocassis micropogon (Bleeker)

1913. *Leiocassis micropogon,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 357.
1936. *Leiocassis micropogon,* Tweedie, *Bull. Raffles Mus. Singapore,* No. 12, p. 19.
1937. *Leiocassis micropogon,* Herre and Myers, *ibid.,* No. 13, p. 69.
1938. *Leiocassis micropogon,* Fowler, *Fisheries Bull. Singapore,* I, pp. 52, 249.

We have examined a single specimen of *Leiocassis micropogon;* it was collected from Bukit Merah, Perak, and is 156 mm. in length.

L. micropogon is found in Sumatra, Banka, Billiton, Borneo, and the Malay Peninsula.

Mystus micracanthus (Bleeker)

1913. *Macrones micracanthus,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 339.
1936. *Macrones micracanthus,* Tweedie, *Bull. Raffles Mus. Singapore,* No. 12, p. 19.
1937. *Mystus micracanthus,* Herre and Myers, *ibid.,* No. 13, p. 69.
1938. *Mystus micracanthus,* Fowler, *Fisheries Bull. Singapore,* No. 1, p. 249.

We have examined two specimens of *Mystus micracanthus* from Perak and Perlis; they are 108 mm. and 103 mm. in length respectively. The species is known to occur in Java, Sumatra, Borneo, Malay Archipelago and Siam.

Mystus nemurus (Cuv. & Val.)

1913. *Macrones nemurus,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 341.
1936. *Macrones nemurus,* Tweedie, *Bull. Raffles Mus. Singapore,* No. 12, p. 19.
1937. *Mystus nemurus,* Herre and Myers, *ibid.,* No. 13, p. 69.
1938. *Mystus nemurus,* Fowler, *Fisheries Bull. Singapore,* No. 1, pp. 52, 249.

We have examined six specimens of *Mystus nemurus* from Singapore, Kelantan, Pahang and Perak; they range in length from 94 mm. to 280 mm. In some of the examples the maxillary barbels extend beyond the anal fin and the outermost ray of the

upper lobe of the caudal fin is produced into a long filamentous process. The range of distribution of this species extends from the Malay Archipelago through the Malay Peninsula to Siam.

Mystus nigriceps (Cuv. & Val.)

1913. *Macrones nigriceps,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 337.

1936. *Macrones nigriceps,* Tweedie, *Bull. Raffles Mus. Singapore,* No. 12, p. 19.

1937. *Mystus nigriceps,* Herre and Myers, *ibid.,* No. 13, p. 69.

1938. *Mystus nigriceps,* Fowler, *Fisheries Bull. Singapore,* No. 1, pp. 52, 249.

Mystus nigriceps is represented in the collection by four specimens which were obtained from Johore, Kedah, Pahang and Perak; they range in length from 85 mm. to 262 mm. In the specimen from Perak, 262 mm. in length, the dorsal spine is relatively longer, being more than the length of the head without snout. In the specimen from Kedah, 91 mm. in length, the diameter of the eye is contained about 5 times, instead of 3 to 4½, in the length of the head, while the base of the anal fin is contained only 3 times in the base of the adipose fin.

M. nigriceps is found in Java, Sumatra, Borneo, Malay Peninsula and Siam.

Mystus planiceps (Cuv. & Val.)

1913. *Macrones planiceps,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 342.

1936. *Macrones planiceps,* Tweedie, *Bull. Raffles Mus.* No. 12, p. 19.

1937. *Mystus planiceps,* Herre and Myers, *ibid.,* No. 13, p. 69.

1938. *Mystus planiceps,* Fowler, *Fisheries Bull. Singapore,* No. 1, pp. 53, 249.

We have examined five specimens of *Mystus planiceps,* ranging from 108 mm. to 405 mm. in length. Two of these, 302 and 405 mm. in length respectively, were collected from the Chenderoh Lake, Perak; two, 108 and 144 mm. in length respectively, were obtained at Kuala Tahan, Pahang; while the fifth specimen, 252 mm. in length, was obtained from Johore. In two examples, the eyes are comparatively smaller, being contained 2¼ times in the length of the snout instead of 1¾ times. In some of the specimens the maxillary barbels are comparatively longer; they extend as far as the commencement of the anal fin.

According to Weber and de Beaufort this fish attains a length of 335 mm. in the Malay Archipelago. We have examined a much larger specimen from Perak.

M. planiceps is found in Java, Sumatra, Borneo, Malay Peninsula and Siam.

Mystus wolffi (Bleeker)

1913. *Macrones wolffi*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 340.
1936. *Macrones wolffi*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 19.
1938. *Mystus wolffi*, Fowler, *Fisheries Bull. Singapore*, No. 1, pp. 53, 249.

We have examined two specimens of *Mystus wolffi;* one measuring 144 mm. in length was collected from Perak, while the precise locality of the other, 176 mm. in length, is not known. In both the specimens the mandibular barbels extend only to the pelvic fins.

Mystus wycki (Bleeker)

1913. *Macrones wycki*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 343.
1936. *Mystus wycki*, Suvatti, *Index Fish. Siam*, p. 77.
1940. *Mystus wycki*, Herre, *Bull. Raffles Mus. Singapore*, No. 16, p. 36.

There is a single specimen of *Mystus wycki* in the collection; it was collected from the Chenderoh Lake, Perak, and is 345 mm. in length. This species has hitherto been known from Java, Sumatra and Siam, but recently it was recorded by Herre from the Malay Peninsula.

Family AMBLYCEPIDÆ

Amblyceps mangois (Hamilton)

1933. *Amblyceps mangois*, Hora, *Rec. Ind. Mus.*, XXXV, pp. 607–621, text-figs. 1–7.
1940. *Amblyceps mangois*, Hora, *Rec. Ind. Mus.*, XLII, p. 374.
1941. *Amblyceps mangois*, Hora, *Supra*, p. 7, pl. I, fig. 3.

Amblyceps mangois is recorded by one of us earlier in this journal (No. 17, p. 7) from the Malay Peninsula (Perak), and now we have 3 young specimens, 47 mm. to 67 mm. in length, from a stream near the River Galas in Kelantan. In these examples the barbels are comparatively long, and the caudal fin is deeply forked without any filamentous prolongations of the outer rays. The body is covered all over with minute rounded tubercles. Taking all the salient features into consideration, the specimens under report agree more closely with the Siamese and the Malayan form than the typical form known from India and Burma.

It may be noted that one of us has recently extended the range of the species westwards to the headwaters of the Mahanadi river in the Central Provinces.

Family AKYSIDÆ

The family Akysidæ is represented by two genera in the fauna of the Malay Peninsula, *viz.*, *Acrochordonichthys* Bleeker, and *Parakysis* Herre. In the former the gill-openings are extensive but are restricted to the ventral surface and extend dorsally only to the bases of the pectoral fins; whereas in the latter the gill-openings are small and are situated just in front of the bases of the pectoral fins. In *Acrochordonichthys* the gill-membranes are united with each other and with the isthmus; whereas in *Parakysis* the gill-membranes are separated from each other by a long distance and, in consequence, the isthmus is very wide.

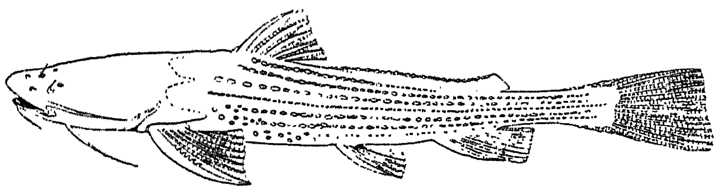
Acrochordonichthys is represented by three species in the Malay Peninsula, two of which are recorded here for the first time, and the third, *A. rugosus* (Bleeker), is recorded by one of us earlier in this journal (No. 17, p. 8) from Perak; we have now examined further material of it from the King George V National Park. *Parakysis* is monotypic so far. Notes on the four Malayan species of the family recently examined by us are given below.

It may be noted that *Akysis* Bleeker is known from Java and Borneo on the one hand and from Burma and Siam on the other. It is likely, therefore, that some representative of this genus will be found in the Malay Peninsula also.

Acrochordonichthys ischnosoma Bleeker

1913. *Acrochordonichthys ischnosoma*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 367.

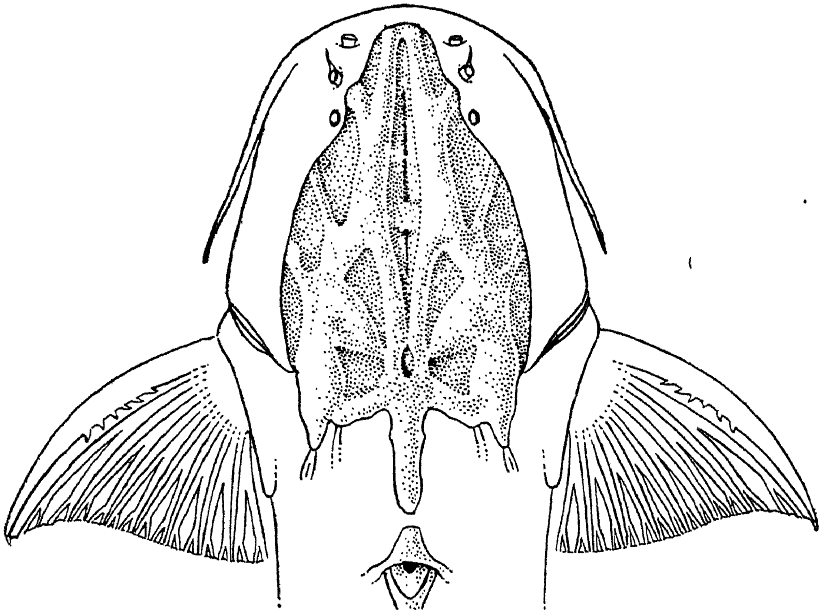
Acrochordonichthys ischnosoma is represented in the collection by a single specimen, 109 mm. in length; it was obtained by Mr. E. O. Shebbeare from the King George V National Park. The entire skin is granular and there are 7 distinct longitudinal rows of tubercles on each side, besides one along the mid-dorsal



Text-fig. 4.—Lateral view in outline of a specimen of *Acrochordonichthys ischnosoma* Bleeker from King George V National Park, Malay Peninsula. ×. ¾.

line. In all salient characters the specimen agrees with the description of the species as given by Weber and de Beaufort and the drawings by Bleeker in his *Atlas Ichthyologique.*

The respiratory adaptations described by one of us (Hora, *loc. cit.*) in *A. rugosus* are also present in the specimen under report, and they seem to form a very characteristic feature of the genus.



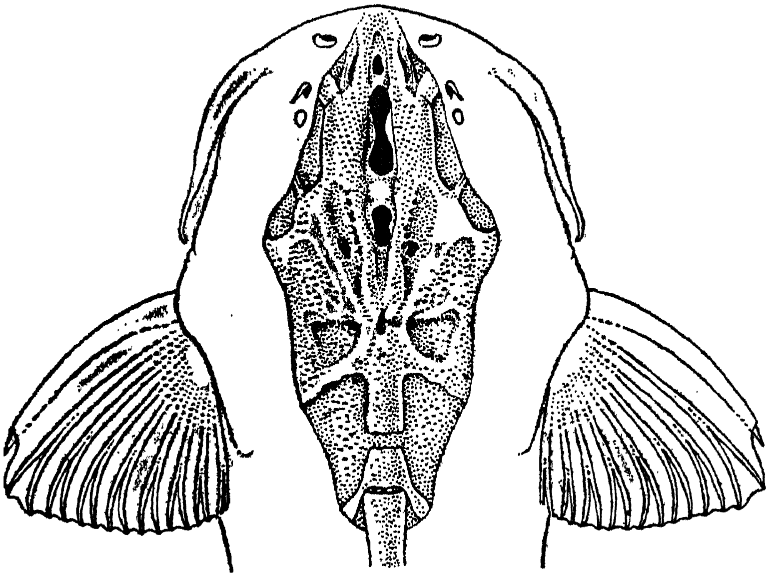
Text-fig. 5.—Dorsal surface of head of *Acrochordonichthys ischnosoma* Bleeker with a part of the skin removed to show the form of occipital process, the position of the fontanels and the associated parts of skull. 2.

Acrochordonichthys melanogaster (Bleeker)

1913. *Acrochordonichthys melanogaster*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 369.

We have examined a single specimen, 99 mm. in length, of *Acrochordonichthys melanogaster;* it was collected at Kuala Tahan, Pahang (King George V National Park). This species has hitherto been known from a single specimen and can be readily distinguished from the allied forms by its quadratic occipital process. According to Bleeker, its median fontanel reaches to the base of the occipital process, but in the specimen from Pahang it is separated by a considerable distance from the occipital process, at the base of which lies another small, rounded fontanel. As pointed out by Weber and de Beaufort in their

note on the doubtful species of *Acrochordonichthys* (p. 370), "It may be that Bleeker has overlooked the fact that these fontanels are separated."



Text-fig. 6.—Dorsal surface of head and anterior part of body of *Acrochordonichthys melanogaster* (Bleeker) with a part of the skin removed to show the form of the occipital process, the position of the fontanels and the associated parts of skull. × 2.

In the specimen under report the dorsal surface from above the commencement of pelvic fins is marked with a whitish patch which extends halfway along the upper border of the caudal fin; in this whitish area only the tip of the adipose fin is black. We agree with Weber and de Beaufort that forms such as *A. pachyderma* Vaillant, *Sosia chamaleon* Vaillant, *A. obscurus* Popta, *A. büttikoferi* Popta and *A. varius* Popta are probably local or colour varieties of *A. melanogaster*. The median fontanel in all these forms is similar to that described above in the specimen from Pahang.

A. melanogaster is known from Sumatra and ? Borneo; it is recorded here from the Malay Peninsula for the first time.

Acrochordonichthys rugosus (Bleeker)

1913. *Acrochordonichthys rugosus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 368.
1941. *Acrochordonichthys rugosus*, Hora, *Bull. Raffles Mus. Singapore,* No. 17, p. 8.

Acrochordonichthys rugosus was only recently recorded by one of us from Perak; we have now examined three more specimens, one from Ulu Lebir, Kelantan, 81 mm. in length, and two from King George V National Park (Pahang), 42 mm. and 45 mm. in length respectively. In the specimen from Kelantan, the dorsal surface from above the pelvic fins to the base of the adipose fin is marked with a broad saddle-shaped whitish area. Behind the adipose fin the dorsal surface up to the middle of the caudal fin is streaked with white. In one of the young specimens this whitish area is more extensive while in the other the sides in the posterior part of the body are marked with three whitish spots.

A. rugosus is now known from Java, Sumatra and the Malay Peninsula.

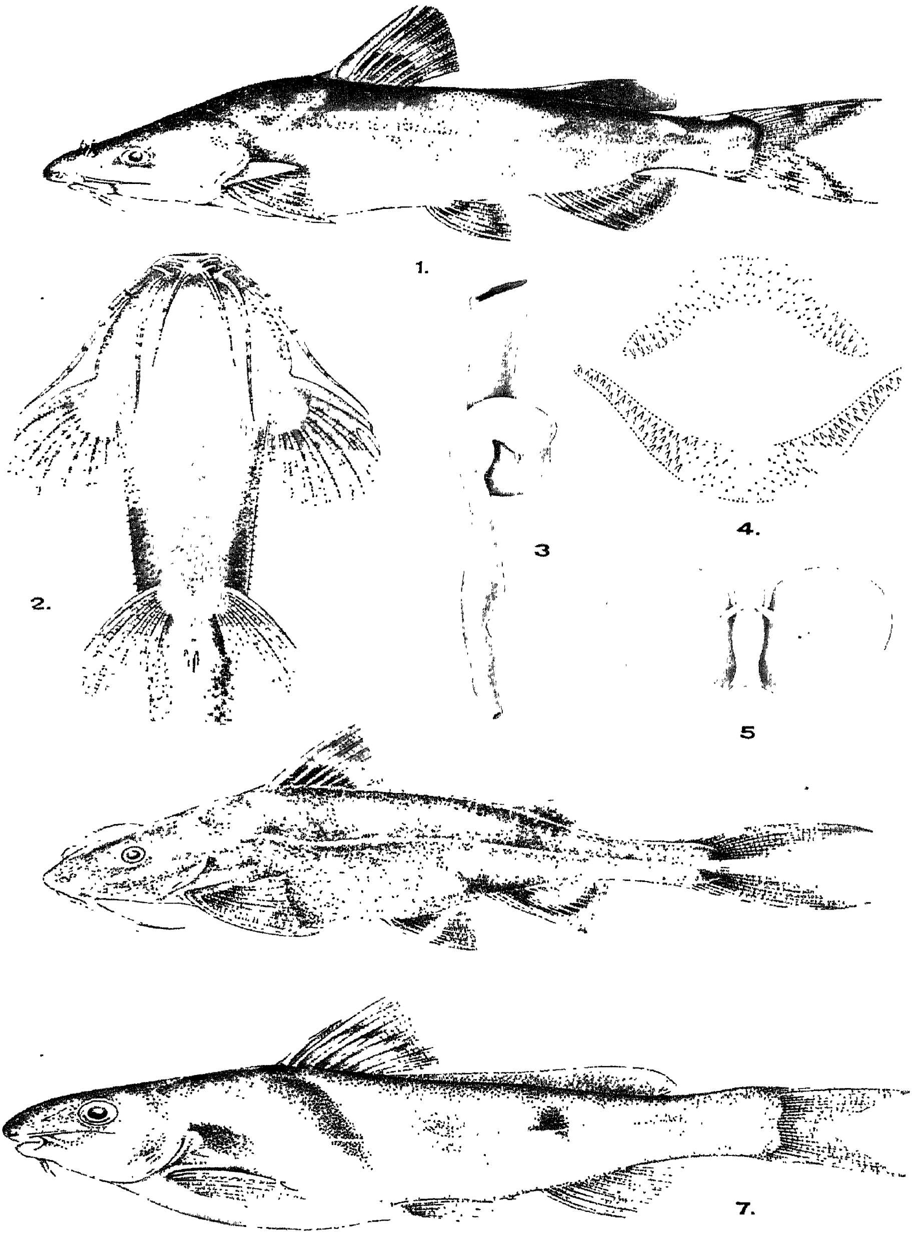
Parakysis verrucosa Herre. (Plate III, fig. 1; plate IV, figs. 2–5)

1940. *Parakysis verrucosa*, Herre, *Bull. Raffles Mus. Singapore*, No. 16, p. 12, pl. vi.

Herre in proposing the genus *Parakysis* noted that "it lacks an adipose dorsal fin", and it is on this character that he seems to have separated it from *Akysis* Bleeker. We have examined 4 young specimens, 26 to 37 mm. in length, of *P. verrucosa* from near Kota Tinggi in S. Johore and find that they possess a long, low and thick adipose fin, which, owing to tubercles on the body, is not distinct unless the specimen is held against the light. It may be noted that Herre also observed that "Some specimens, especially those from Borneo, have a low ridge or keel on the dorsal side of the caudal peduncle". The two genera are, however, abundantly distinct in their general build, the nature of gill-opening and barbels. In *Akysis* the gill-openings extend to the ventral surface for a considerable distance though there is still a broad isthmus separating them; while in *Parakysis* the gill-openings extend just round the base of the pectoral spine and the isthmus is very broad. The small gill-openings of *Parakysis* are still further reduced functionally as valve-like folds inside the gill-openings restrict the flow of the expiratory current to the upper portion where a spout-like structure is formed somewhat similar to that found in *Amblyceps*[1]. The presence of short, accessory, basal barbules at the bases of the mandibulary and mental barbels is a characteristic feature of *Parakysis*.

The alimentary canal (pl. iv, fig. 3) of *P. verrucosa* is a simple tube with only one convolution; there is no marked differentiation between the stomach and other parts of the

1. Hora, S. L.—Siluroid Fishes of India, Burma and Ceylon. I. Loach-like Fishes of the genus *Amblyceps* Blyth. *Rec. Ind. Mus.*, XXXV, p. 611, text-fig. 3 (1933).



del. Siluroid Fishes from the Malay Peninsula.

alimentary canal. The air-bladder (pl. iv, fig. 5) is thin-walled; it is divided into two small rounded chambers which are dorsally enclosed in bony capsules and are connected with *ductus endolymphaticus* by short tubes. The teeth (pl. iv, fig. 4) are villiform and arranged in bands in the jaws; the palate is edentulous.

In general features *Parakysis* appears to be closely related to *Akysis,* but seems to be better adapted for life in torrential streams; its restricted gill-openings and the presence of accessory barbules round the mouth indicate respiratory adaptations for life in swift currents.

P. verrucosa is known from Johore (Malay States) and Sarawak (Borneo).

Family SISORIDÆ

The characteristic mountain catfishes of the family Sisoridæ are represented in the fauna of the Malay Peninsula by the genera *Bagarius* Bleeker and *Glyptothorax* Blyth. The two genera can readily be distinguished by the thoracic adhesive apparatus composed of longitudinal plaits of skin which is absent in the former and present in the latter.

In his list of Malayan fishes, Fowler[1] has included *Aspidobagrus gulio* (Ham.) in the family Bagariidæ which is probably an oversight, as this species belongs to the family Bagridæ.

Bagarius is represented by the widely distributed species *B. bagarius* (Ham.), while *Glyptothorax* is represented by four species, *viz., G. majus* (Blkr.), *G. platypogon* (Cuv. & Val.), *G. platypogonoides* (Blkr.) and *G. telchitta* (Ham.). Of the first species, which was recently recorded by Herre from the Malay Peninsula, we have examined several specimens, four of which had been determined by Herre as *G. majus.*

We have not examined any specimen of *G. telchitta,* which was found at Kuala Lumpur by Duncker (Fowler, *loc. cit.,* p. 48). The precise specific limits of Hamilton's *telchitta* are not known[2] and it seems to us probable that the species does not occur outside northern Bengal and Bihar. The occurrence of this species in the Malay Peninsula is thus doubtful. Of *G. platypogonoides* we have examined three specimens, two of which were determined by de Beaufort as such and are now in a very bad state of preservation.

1. Fowler, H. W.—A list of the Fishes known from Malaya. *Fisheries Bull. Singapore,* No. 1, p. 47 (1938).
2. Hora, S. L.—Notes on Fishes in the Indian Museum. V. On the Composite Genus *Glyptosternon* McClelland. *Rec. Ind. Mus.,* XXV, p. 28 (1923).

Bagarius bagarius (Hamilton)

1913. *Bagarius bagarius*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 270.
1936. *Bagarius bagarius*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1938. *Bagarius bagarius*, Fowler, *Fisheries Bull. Singapore*, No. 1, pp. 47, 248.
1939. *Bagarius bagarius*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XL, pp. 583–593.

Tweedie (*loc. cit.*) has examined a specimen of *Bagarius bagarius* from Singapore, and informs us (*in litt.*) that he has obtained the species at Kuala Tahan. The only other locality in the Malay Peninsula whence it has been recorded is Telan Stream, Perak-Pahang Boundary.

B. bagarius is very widely distributed in the Oriental region. It is a very ancient fish as its fossil remains are known from the Tertiary deposits of the highlands of Padang in Sumatra and the Siwalik rocks of India.

Glyptothorax majus (Boulenger). (Plate III, fig. 2)

1894. *Akysis major*, Boulenger, *Ann. Mag. Nat. Hist.* (6) XIII, p. 246.
1911. *Glyptosternum major*, Regan, *Ann. Mag. Nat. Hist.* (8) VIII, p. 563.
1913. *Glyptosternum majus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 267.
1940. *Glyptothorax majus*, Herre, *Bull. Raffles Mus. Singapore*, No. 16, p. 35.

Glyptothorax majus was described by Boulenger as *Akysis* from several specimens collected in the rivers of Sarawak, Borneo. Regan pointed out its true generic position. According to Weber and de Beaufort, specimens of this species from Borneo had been referred to *G. platypogonoides* by Vaillant and *G. nieuwenhuisi* by Popta. Herre recorded it from several localities in the Malay Peninsula. We have examined specimens of *G. majus* from the following localities:—

	specimens	*mm.*
West of Ginting Sempak, Selangor	1	47
Mawai District, Johore	3	39–44
Jalong, Perak	10	58–73
River Condor, Ulu Galas, Kelantan	3	43–71
River Ketil, Kelantan	5	50–61
Kuala Tahan, Pahang	1	46

The most characteristic feature of the species is its colouration which, according to Boulenger, is as follows:—

> "Dark brown above, whitish beneath; dorsal, pectoral, and adipose fins blackish brown, with a white border; ventrals and anal white, with one or two black bars; caudal blackish brown or black and white, the lobes constantly tipped with white."

The body is covered with well-marked tubercles and the dorsal spine is feebly denticulated in parts along the posterior

border. In the young specimens the body is somewhat more slender and the dorsal spine is sometimes smooth. There is considerable difference in the depth of colouration of the various specimens examined by us, but the general pattern is more or less the same.

Besides Borneo and the Malay Peninsula, *G. majus* has also been recorded from Siam.[1]

Glyptothorax platypogon (Cuv. & Val.)

1913. *Glyptosternum platypogon,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 264, fig. 104.
1937. *Glyptothorax platypogon,* Herre and Myers, *Bull. Raffles Mus. Singapore,* No. 13, p. 68.

Herre and Myers have already recorded *Glyptothorax platypogon* from Johore and Perak. We have examined one specimen from Kuala Tahan, Pahang, which is 70 mm. in length. *G. platypogon* is readily distinguished from the allied species by its broad caudal peduncle and colouration, which is "Lighter or dark olivaceous brown, often with dark spots scattered over the back; belly, underside of head and ventral barbels whitish. Rayed fins of the same colour, their base and irregular peripheral patches dark. Base of caudal dark."

In the specimen under report the lower lobe of the caudal fin is considerably longer. Probably this is an abnormal feature of the specimen.

G. platypogon is known from Java, Sumatra, Borneo and the Malay Peninsula.

Glyptothorax platypogonoides (Bleeker). (Plate IV, fig. 6)

1913. *Glyptosternum platypogonoides,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 267.
1936. *Glyptosternum platypogonoides,* Tweedie, *Bull. Raffles Mus. Singapore,* No. 12, p. 18.
1938. *Glyptothorax platypogonoides,* Fowler, *Fisheries Bull. Singapore,* No. 1, p. 248.
1940. *Glyptothorax platypogonoides,* Herre, *Bull. Raffles Mus. Singapore,* No. 16, p. 36.

As pointed out above, two specimens from Ulu Jelai, Pahang, were referred by de Beaufort to *Glyptothorax platypogonoides* and were listed by Tweedie in 1936. These specimens are in a desiccated condition and in a bad state of preservation. We are, therefore, unable to make any comments on them. There are, however, three specimens, 65–71 mm. in length, collected from King George V National Park, which can be definitely assigned to this species. One of the specimens is full of eggs, and in consequence the depth of the body is proportionately greater, but its narrow caudal peduncle enables it to be readily distinguished from *G. majus*. Moreover, in *G. platypogonoides*

1. Suvatti, C.—*Index to Fishes of Siam,* p. 343 (1936).

the colour is "Greenish violet with blue dots; lateral line yellow; dorsal and anal fin with a broad band along the base and along their outer portion; adipose fin and caudal dotted with brown".[1]

In the specimens examined by us the mandibulary barbels are $^3/_5$ of the length of head, instead of being equal to it, and the occipital process is somewhat broader.

Besides Sumatra, *G. platypogonoides* is known from the Malay Peninsula and Siam[2].

Family CHACIDÆ

Chaca chaca (Hamilton)

1913. *Chaca chaca,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 246.
1936. *Chaca chaca,* Tweedie, *Bull. Raffles Mus. Singapore,* No. 12, p. 18.
1937. *Chaca chaca,* Herre and Myers, *ibid.,* No. 13, p. 67.
1938. *Chaca chaca,* Fowler, *Fisheries Bull. Singapore,* No. 1, p. 247.
1940. *Chaca chaca,* Herre, *Bull. Raffles Mus. Singapore,* No. 16, p. 35.

We have examined a specimen, 118 mm. long, of *Chaca chaca* from the Mawai District, Johore. This is a very queer looking catfish, and is the sole representative of the family. It can readily be distinguished by its short anal fin, which is free from the caudal fin; by the presence of six rays in the pelvic fins, a strong, pungent spine in the dorsal fin and the union of the so-called second dorsal fin with caudal fin to form a procurrent caudodorsal.

Family SCHILBEIDÆ

In Siam and the Malay Archipelago, the family Schilbeidæ is represented by at least four genera in each region which are either identical or closely allied. *Helicophagus* Bleeker, *Laides* Jordan and *Pangasius* Cuvier & Valenciennes are common to the two regions, while *Pseudeutropius* Bleeker is replaced by *Platytropius* Hora in Siam. From the Malay Peninsula, however, no representative of *Helicophagus, Pseudeutropius* or *Platytropius* has yet been described, but it is likely that some members of these genera may be found in the Malay Peninsula. Similarly some species of *Pangasius,* such as *P. nasutus* and *P. macronema,* are not known so far from the Malay Peninsula though they have been recorded from Siam, Borneo and Sumatra.

In the fauna of the Malay Peninsula, this family is represented by *Laides hexanema* (Blkr.), *Pangasius micronema*

1. Günther, A.—*Catalogue of the Fishes in the British Museum,* V, p. 186 (1864).
2. Suvatti, C.—*Index to Fishes of Siam,* p. 81 (1936).

Blkr., *P. pangasius* (Ham.), *P. polyuranodon* Blkr.[1] and *P. ponderosus* Herre & Myers[2].

Laides hexanema (Bleeker)

1913. *Lais hexanema*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 250.
1936. *Lais hexanema*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1938. *Lais hexanema*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 47.

We have examined a single specimen of *Laides hexanema* from the Pahang River; it is 84 mm. in length. On comparing it with Weber and de Beaufort's description, we find that its eyes are proportionately smaller (about 3½ in head instead of 3, space between the eyes on the ventral surface more than diameter of eye), mandibular barbels are shorter (stopping a considerable distance away from pectorals instead of extending to base of pectorals) and the distal portions of the dorsal, pectoral, pelvic, and caudal fins are somewhat lighter in colour instead of being darker.

L. hexanema is found in Java, Sumatra, Borneo, Malay Peninsula and Siam.

Pangasius micronema Bleeker

1913. *Pangasius micronema*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 261.
1937. *Pangasius micronema*, Herre and Myers, *Bull. Raffles Mus. Singapore*, No. 13, p. 67.
1940. *Pangasius micronema*, Herre, *ibid.*, No. 16, p. 35.

We have examined 3 specimens of *Pangasius micronema*, ranging in standard length from 245 to 318 mm., they were collected from the Chenderoh Lake, Perak. In these examples the mandibular barbels are rudimentary, the vomerine and palatine teeth do not form distinct patches but those on each side are united into a common band. The eyes are somewhat more ventrally placed as the distance between them on the ventral surface is about 1·75 times the diameter of the eye.

P. micronema is known from Java, Sumatra, Borneo, Perak and Siam.

Pangasius pangasius (Hamilton)

1913. *Pangasius pangasius*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 256.
1936. *Pangasius pangasius*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1937. *Pangasius pangasius*, Herre & Myers, *ibid.*, No. 13, p. 67.
1938. *Pangasius pangasius*, Fowler, *Fisheries Bull. Singapore*, No. 1, pp. 47, 248.

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1. Fowler, H. W.—A list of the Fishes known from Malaya. *Fisheries Bull. Singapore*, No. 1, p. 47 (1938).

2. Herre, W. C. T. and Myers, G. S.—A contribution to the Ichthyology of the Malay Peninsula. Part II. Fresh-water Fishes. *Bull. Raffles Mus. Singapore*, No. 13, p. 67 (1937).

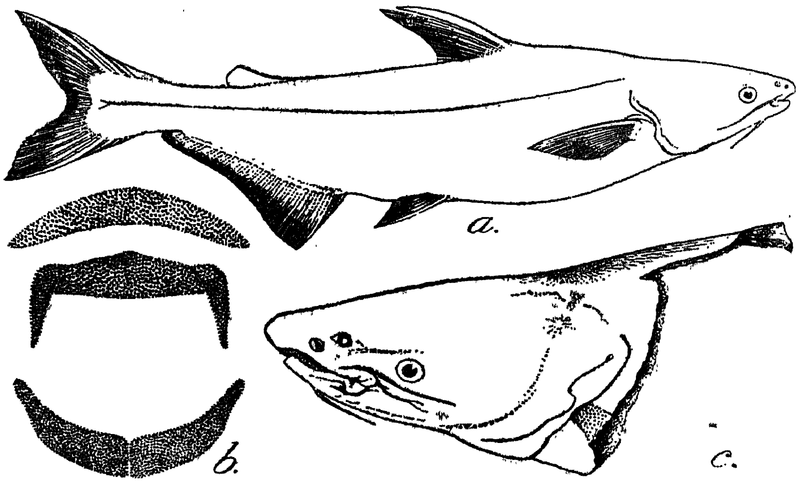
A juvenile specimen of the widely distributed Indian species *Pangasius pangasius* was recorded by Tweedie, (*loc. cit.*) ; it was obtained from the Pahang River near Mentakab. Herre and Myers recorded it from Perak.

Pangasius ponderosus Herre & Myers

1937. *Pangasius ponderosus*, Herre and Myers, *Bull. Raffles Mus. Singapore*, No. 13, p. 67, pl. vi.

Mr. Tweedie collected a specimen of *Pangasius ponderosus*, 27 inches long, from Kuala Tahan, Pahang. Being unable to preserve the entire specimen he took a photograph and the following particulars about the individual and then preserved its head.

"Length with caudal	27 inches.
Depth	6 ,,
Depth of caudal peduncle ..	1¾ ,,
Rays in dorsal	1/7
Rays in anal	3/23
Rays in pectoral	1/11
Rays in ventral	1/5



Text-fig. 7.—*Pangasius ponderosus* Herre and Myers.
a. Lateral view of a specimen 27 inches long from Kuala Tahan, Pahang. The sketch was made from a photograph and data supplied by Mr. M. W. F. Tweedie, while the head portion was finished from the specimen; *b.* Upper and lower dentition. × ½; *c.* Lateral view of head. × ½.

A group of large pores exuding slime is in the axil of each pectoral. Colour greyish green above, livid white below, the dividing line between the two running ½ inch above the lateral

line behind ventrals; descending thence to pectorals and about level of eye on head".

A detailed study of the head has shown that it differs in the following particulars from Herre and Myers' description of the species:—

(i) The eye is somewhat smaller, its diameter being contained 13 times in head (*versus* 11 times) and about 8·5 times in interorbital width (*versus* 6·25 times).

(ii) The posterior nostril is more or less in a line with the anterior one, instead of being much higher.

(iii) The mandibular barbel is nearly 2½ times the diameter of the eye, instead of being a little longer than the eye.

As the species is known from only two specimens, we regard these differences as individual variations and attach no specific value to them.

A reference to literature has shown that Fowler's *Pangasius taeniura* from Siam is very closely allied to *P. ponderosus*. In the former the barbels are somewhat longer and the head and the eyes are proportionately larger. These differences may be due to the fact that the only specimen known of *P. taeniura* is 85 mm. in total length, while the two known examples of *P. ponderosus* are over 600 mm. in length. When further material of the two species becomes available, it is likely that they will be found to be identical.

Pangasius ponderosus is so far known only from the Malay Peninsula.

Family CLARIIDÆ

The family Clariidæ is represented by six species in the fauna of the Malay Peninsula; they are distributed in three genera which may be distinguished by the following key:—

Key to the Malayan genera of the Clariidæ

A. Dorsal fin divided into two parts, the first of soft rays, the second an adipose fin of great length .. .. *Encheloclarias* Herre & Myers.[1]

B. Dorsal fin long and undivided, composed of soft rays only—

- I. Dorsal, caudal and anal fins normally confluent to form a single fin .. *Prophagorus* Smith.[2]
- II. Dorsal, caudal and anal fins separate *Clarias* Gronovius.

[1] Herre, A. W. C. T. and Myers, G. S.—A Contribution to the Ichthyology of the Malay Peninsula. Part II. Fresh-water Fishes. *Bull. Raffles Mus. Singapore,* No. 13, p. 68 (1937).

[2] Smith, H. M.—A New Genus of Clariid Catfishes. *Copeia,* No. 4, p. 236 (1939).

The first two genera are monotypic, each being represented by a single species. *Encheloclarias tapeinopterus* (Bleeker) had hitherto been included in the African genus *Heterobranchus* Geoffroy St. Hilaire and was only known from Banka and Sarawak (Borneo). Dr. A. W. C. T. Herre obtained a living specimen at Mawai, Johore. We have not examined any specimen of this species. *Prophagorus nieuhofi* (Cuvier & Valenciennes) is found in Java, Sumatra, Banka, Biliton, Borneo, Philippines, Malay Archipelago and Siam. We have examined one partly desiccated specimen of the species and find that on the nature of its confluent vertical fins it may merit a generic distinction from *Clarias*, a genus which is widely distributed in Africa, Syria, Southern Asia and the East Indian Archipelago.

Clarias batrachus (Linnaeus)

1913. *Clarias batrachus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 190.
1936. *Clarias batrachus*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1937. *Clarias batrachus*, Herre and Myers, *ibid.*, No. 13, p. 65.
1938. *Clarias batrachus*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 43.

Clarias batrachus is the most widely distributed species of the Oriental Region; we have examined four specimens, ranging in length from 120 to 182 mm., from Perlis, Singapore and Kedah. The interorbital distance is liable to vary considerably; in two specimens it is contained almost twice in the length of the head.

Clarias leiacanthus Bleeker

1913. *Clarias leiacanthus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 192.
1936. *Clarias leiacanthus*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1937. *Clarias leiacanthus*, Herre and Myers, *ibid.*, No. 13, p. 65.
1938. *Clarias leiacanthus*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 247.

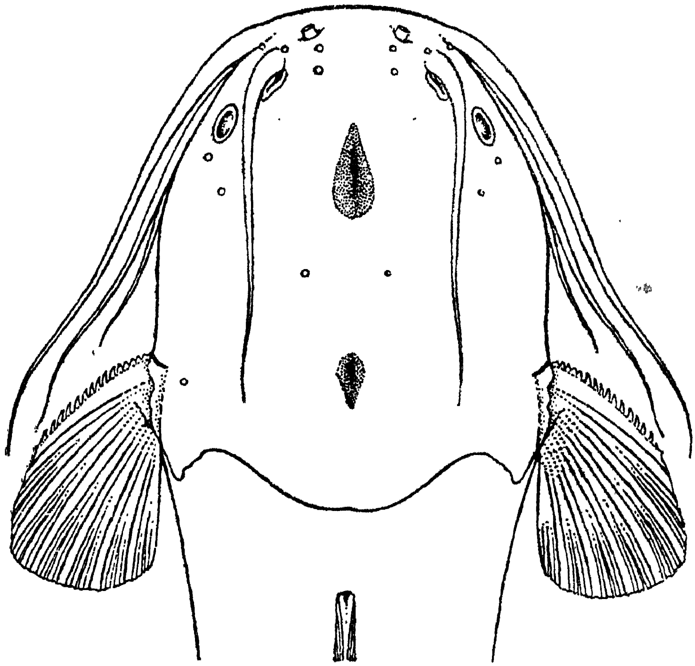
We have examined four specimens of *Clarias leiacanthus*, three from Perak and one from Johore; they vary in length from 245 mm. to 395 mm. It may be noted that according to Weber and de Beaufort this species attains a length of 330 mm. in the Malay Archipelago; two specimens from Chenderoh Lake, Perak, are 360 mm. and 395 mm. in length respectively.

In two of the specimens under report the pectoral spine, which is generally smooth, is feebly serrated; while the maxillary barbels do not reach the pelvic fins by a considerable distance in any of the specimens (according to Weber and de Beaufort they nearly reach the pelvic fins).

Clarias melanoderma Bleeker

1913. *Clarias melanoderma,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* II, p. 188.
1937. *Clarias melanoderma,* Herre and Myers, *Bull. Raffles Mus. Singapore,* No. 13, p. 66.
1938. *Clarias melanoderma,* Fowler, *Fisheries Bull. Singapore,* No. 1, p. 44.

Clarias melanoderma is characterised by the possession of strong, almost vertical teeth on the front margin of pectoral spine. We refer to this remarkable species two specimens, about 109 mm. and 193 mm. in length respectively; they were



Text-fig. 8.—Upper surface of head and anterior part of body of a specimen of *Clarias melanoderma* Bleeker from the King George V National Park, Malay Peninsula. × 1½.

collected from King George V National Park. These specimens do not agree with the description of the species by Weber and de Beaufort in the following particulars:—

(i) In the smaller specimen the distance between the dorsal fin and the occipital process is ¼ (instead of $^1/_6$) of the distance between the last-named and the tip of the snout.

(ii) The front border of the frontal fontanel is in line with the front borders of the eyes, instead of being behind the eyes.

(iii) The nasal barbels reach occipital fontanel, instead of the dorsal fin.

(iv) In the larger specimen the length of the pectoral fin is relatively less, being equal to the postorbital part of the head to the gill-opening.

(v) In the larger specimen the general colouration is a neutral tint with black spots irregularly distributed over the body and fins.

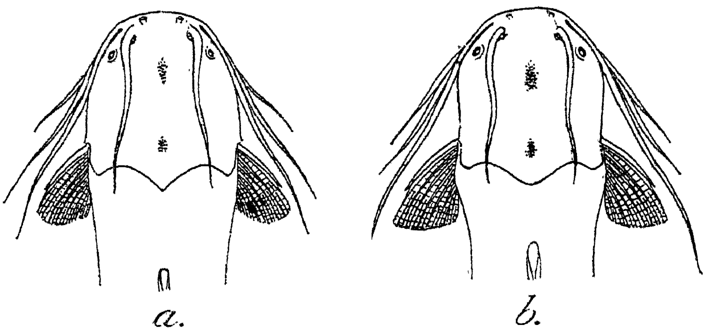
As the species grows to about 340 mm. in length, we do not attach any specific value to the above noted differences.

Clarias melanoderma is found in Java, Sumatra, Borneo, Philippines, Siam and China.

Clarias teysmanni Bleeker

1913. *Clarias teysmanni*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 191.
1936. *Clarias teysmanni*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1937. *Clarias teysmanni*, Herre and Myers, *ibid.*, No. 13, p. 66.
1938. *Clarias teijsmanni*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 44.

We have examined three specimens of *Clarias teysmanni* from Kelantan and Johore; they range in length from 171 to 180 mm. The shape of the occipital process is variable. In the



Text-fig. 9.—Upper surface of head and anterior part of body of two specimens of *Clarias teysmanni* Bleeker from Malaya, showing differences in the shape of the occipital process. *a.* From Kelantan; *b.* From Johore.

two specimens from Kelantan it is distinctly pointed, while in the example from Johore it is broadly pointed. In the Kelantan specimens the distance between the occipital process and the dorsal fin is also proportionately greater.

Prophagorus nieuhofi (Cuv. & Val.)

1913. *Clarias nieuhofi*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, II, p. 189.
1936. *Clarias nieuhofi*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 18.
1938. *Clarias nieuhofi*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 44.
1939. *Prophagorus nieuhofi*, Smith, *Copeia*, No. 4, p. 236.
1940. *Clarias nieuhofi*, Herre, *Bull. Raffles Mus. Singapore*, No. 16, p. 35.

We have examined a single specimen of *Prophagorus nieuhofi* from the Sedagong River, Tioman Island on the east coast of the Malay Peninsula; it is 310 mm. in length and is partly desiccated. A portion of the dorsal fin near its junction with the caudal is damaged. On comparing it with the description of the species as given by Weber and de Beaufort, we find that its head is considerably longer than its breadth (*versus* "Length of head to gill-opening nearly equalling its greatest breadth") and the interorbital distance is less than the width of the mouth (*versus* "Eye-distance greater than mouth opening").

EXPLANATION OF PLATE II

Fig. 1.—Lateral view of a specimen of *Silurichthys schneideri* Volz from Jalong, Perak. × ¾.
Fig. 2.—Lateral view of a specimen of *Leiocassis fuscus* Popta from Mawai District, Johore. × 3.

EXPLANATION OF PLATE III

Fig. 1.—Lateral view of a specimen of *Parakysis verrucosa* Herre from Kota Tinggi, S. Johore. × 3¾
Fig. 2.—Lateral view of a specimen of *Glyptothorax majus* (Boulenger) from Ketil R., Kelantan. × 2¼

EXPLANATION OF PLATE IV

Fig. 1.—Lateral view of a specimen of *Leiocassis baramensis* Regan from the Malay Peninsula. × 2/3
Fig. 2.—Ventral surface of head and anterior part of body of a specimen of *Parakysis verrucosa* Herre from Kota Tinggi, S. Johore. × 3 1/3
Fig. 3.—Alimentary canal of *Parakysis verrucosa* Herre. × 7.
Fig. 4.—Dentition of same. × 24.
Fig. 5.—Air-bladder of same. × 8.
Fig. 6.—Lateral view of a mature female specimen of *Glyptothorax platypogonoides* (Bleeker) from King George V National Park. × 1 1/3
Fig. 7.—Lateral view of a specimen of *Batasio tengana* (Hamilton) from Chenderoh Lake, Perak. × 1

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Notes on Malayan fishes in the collection of the Raffles Museum, Singapore, Parts 2, 3

by

SUNDER LAL HORA

Notes on Malayan fishes in the Collection of the Raffles Museum, Singapore. Parts 2 and 3.

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2. Loaches of the family Cobitidæ

The following 11 species of the Cobitidæ have so far been known to occur in the fauna of the Malay Peninsula:—

1. *Acanthophthalmus kuhli* (Cuv. & Val.).
2. *Acanthophthalmus muraeniformis* de Beaufort.
3. *Acanthophthalmus perakensis* (Herre).
4. *Acanthophthalmus pahangensis* de Beaufort.
5. *Acanthophthalmus semicinctus* Fraser-Brunner.
6. *Acanthopsis choirorhynchus* (Bleeker).
7. *Botia hymenophysa* (Bleeker).
8. *Lepidocephalus furcatus* de Beaufort.
9. *Lepidocephalus hasselti* (Cuv. & Val.).
10. *Nemachilus fasciatus* (Cuv. & Val.).
11. *Nemachilus selangoricus* Duncker.

I have examined specimens of all these species except of *A. kuhli*, the doubtful occurrence of which in the Malay Peninsula is discussed under *A. semicinctus*. It has been found that Herre's *Acanthophthalmus perakensis* is synonymous with *A. anguillaris* Vaillant and that *A. pahangensis* de Beaufort is synonymous with *Lepidocephalus macrochir* (Bleeker). Besides the species enumerated above, I have found representatives of the following other species in the collection:—

1. *Acanthophthalmus pangia* (Ham.).
2. *Acanthophthalmus vermicularis* Weber & de Beaufort.
3. *Botia modesta* Bleeker.
4. *Nemachilus masyæ* Smith.

Of the 15 species of the Cobitidæ now known from the Malay Peninsula, *Acanthophthalmus kuhli, Acanthopsis choirorhynchus, Botia hymenophysa, Lepidocephalus hasselti* and *Nemachilus fasciatus* are found both to the north and south of the Malay Peninsula. *Acanthophthalmus anguillaris* and *A. pangia* had hitherto been known from the north and south of the Malay Peninsula, but are recorded here from this region for the first time. *Botia modesta* and *Nemachilus masyæ* were so far known from Siam and are recorded here from the Malay Peninsula for the first time. *Acanthophthalmus vermicularis*

and *Lepidocephalus macrochir* were hitherto known from Sumatra and Java and their range is now extended to the Malay Peninsula. The remaining three species, *Acanthophthalmus muraeniformis, Lepidocephalus furcatus* and *Nemachilus selangoricus* are so far endemic to the Malay Peninsula.

The distribution of the various species enumerated above shows the great importance of the study of the freshwater fish-fauna of the Malay Peninsula for a proper elucidation of the zoogeographical relations of the various countries included in the Oriental Region. From a large number of new records of distribution of the species discussed in this article, it seems probable that a proper search in suitable localities will bring to light many more interesting forms. Even now, so far as the Cobitidæ are concerned, the Malayan fauna seems to be fairly rich in these loaches.

The Malayan species of the Cobitidæ can be distinguished by the following key:—

Key to the Malayan species of Cobitidæ

I. A moveable pre- or suborbital spine—

A. Origin of dorsal before that of ventrals—

1. Spine below eye; eyes with a free orbital margin .. .. .. *Botia.*

a. Length of head equals depth of body; suborbital spine extending to below posterior margin of eye; a broad black bar at base of skull *B. modesta.*

b. Length of head greater than depth of body; suborbital spine extending to below middle of eye; body marked with transverse bands with black edges .. *B. hymenophysa.*

2. Spine before eye: eyes subcutaneous .. *Acanthopsis choirorhynchus.*

B. Origin of dorsal opposite to or behind that of ventrals—

1. Head without scales .. .. *Acanthophthalmus.*

a. Eight barbels—

i. An extra pair of nasal barbels present; end of dorsal above commencement of anal .. *A vermicularis.*

ii. An extra pair of labial barbels present; end of dorsal somewhat before origin of anal .. *A. muraeniformis.*

b. Six barbels—

i. Height 8–11 in total length with caudal—

α. Dorsal its own length or more before anal; colour uniform .. *A. pangia.*

β. Dorsal much less than its own length before anal; 12 to 15 transverse bands on head and body—

*. Head 6½ in length. Ventral fins in middle of length of fish (including caudal fin). Dorsal fin 2/6 — *A. semicinctus.*

**. Head about 8 in length. Ventral fins well behind middle of length of fish. Dorsal fin 2/7–8 .. — *A. kuhli.*

ii. Height 15 or more in total length .. .. — *A. anguillaris.*

2. Scales below and behind eyes and on opercles .. .. .. — *Lepidocephalus.*

a. Caudal distinctly emarginate .. — *L. furcatus.*

b. Caudal truncate—

i. Origin of dorsal behind base of ventrals; pectorals falcate — *L. macrochir.*

ii. Origin of dorsal opposite to base of ventrals; pectorals rounded .. .. — *L. hasselti.*

II. Without pre- or suborbital spine . — *Nemachilus.*

A. Body marked with continuous transverse bands—

1. Bands separated by very narrow interspaces edged with black; outer rostral and maxillary barbels almost extending to gill-opening .. .. .. — *N. selangoricus.*

2. Bands separated by relatively wider interspaces without black edges; barbels not extending to gill-openings .. — *N. fasciatus.*

B. Body marked with saddle-shaped spots along the back and similar series of spots along the middle of the sides .. .. .. — *N. masyæ.*

Acanthophthalmus (Acanthophthalmus) kuhli (Cuvier & Valenciennes)

1916. *Acanthophthalmus kuhli,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* III, p. 33.

1937. *Acanthophthalmus kuhlii,* Herre and Myers, *Bull. Raffles Mus. Singapore,* No. 13, p. 65.

1938. *Acanthophthalmus kuhlii,* Fowler, *Fisheries Bull. Singapore,* No. 1, p. 53.

1940. *Acanthophthalmus kuhli*, Herre, *Bull. Raffles Mus. Singapore*, No. 16, p. 33.

I have not examined any typical specimen of *Acanthophthalmus kuhli*, though it has been recorded from several localities in the Malay Peninsula and Siam. Recently, Fraser-Brunner[1] restricted the distribution of this species to "Sumatra; Java; ? Borneo", and proposed a new species, *A. semicinctus*, for certain specimens from the Mawai District, Johore, referred by Herre (*loc. cit.*) to *A. kuhli*. In view of these findings it is difficult to comment on the earlier records of the species from the Malay Peninsula without examining the series of specimens on which they are based. The above synonymy is, therefore, intended only to set forth the earlier records of *A. kuhli* from this region. For further details, however, reference may be made to the account of *A. semicinctus* (*vide infra*, p. 47).

Acanthophthalmus (Acanthophthalmus) pangia (Hamilton)

1916. *Acanthophthalmus pangia*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 31, fig. 13.

Acanthophthalmus pangia is represented in the collection by 16 specimens ranging in length from 39 mm. to 47 mm. They were collected at Kuala Tahan, Pahang (King George V National Park) and are of a uniformly brownish colour which is somewhat lighter on the ventral surface. This species has been known to occur in Java and Sumatra on the one hand and in Burma and north-eastern Bengal on the other. It is recorded here from the Malay Peninsula for the first time.

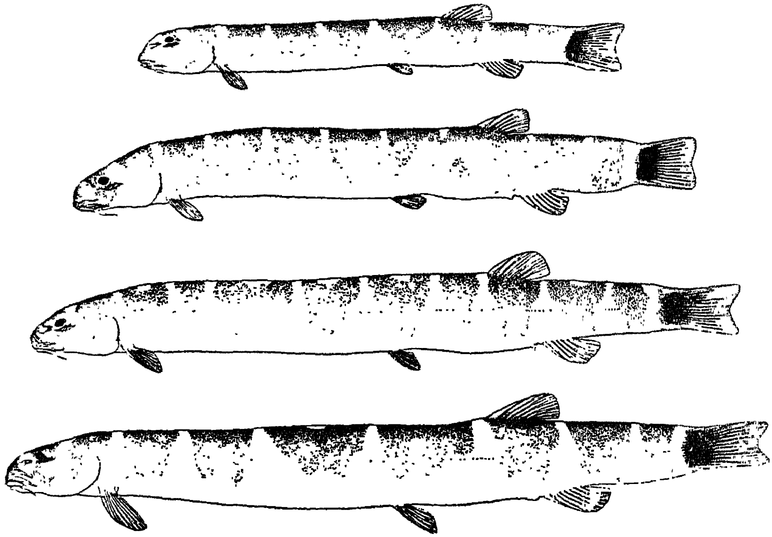
Acanthophthalmus (Acanthophthalmus) semicinctus Fraser-Brunner.

1940. *Acanthophthalmus semicinctus*, Fraser-Brunner, *Ann. Mag. Nat. Hist.*, (11) VI, p. 172, text-fig. 1*b* and 3.

In a recent contribution "On some Fishes of the genus *Acanthophthalmus*, with Description of a new Species", Fraser-Brunner has separated some specimens from the Mawai District, Johore, identified by Dr. Herre as *A. kuhli* into a new species, *A. semicinctus*, and remarked that "This species is very distinct from *A. kuhli*, not only on account of its pattern but by reason of its stouter form, larger head and the position of its anal fin." The four specimens from the collection of the Raffles Museum examined by me also came from the same source and agree with the description and figures of *A. semicinctus* in all salient

1. Fraser-Brunner, A.—On some Fishes of the Genus *Acanthophthalmus*, with Description of a new Species. *Ann. Mag. Nat. Hist.* (11) VI, pp. 170–175 (1940).

features, though there are slight differences as shown in the figures reproduced here.



Text-fig. 1.—Lateral view of four specimens of *Acanthophthalmus semicinctus* Fraser-Brunner from the Mawai District, Johore, in the collection of the Zoological Survey of India.

Weber and de Beaufort[1] recorded *A. kuhli* from Sumatra, Java, Borneo, Singapore and Malacca, but Fraser-Brunner has given as its habitat "Sumatra; Java; ? Borneo". The two specimens of this species examined by him in the collection of the British Museum are from Java and Sumatra respectively. The colour patterns of the two are so distinct that they have been assigned to two separate subspecies. Further, it has been surmised that "when these fishes are better known, each island in the Malay Archipelago will be found to have its own species, subspecies, or race belonging to this group".

In view of the above taxonomic findings, the present records of *A. kuhli* from Siam and the Malay Peninsula require further elucidation. In recording this species from Siam (Chantaboon), Fowler[2] observed: "A very variable species pattern, most of the examples not even alike on both sides of the body. Bleeker's imperfect figure in 1863 does not show the species satisfactorily.

1. Weber, M. and de Beaufort, L. F.—The Fishes of the Indo-Australian Archipelago, III, p. 33 (Leiden: 1916).

2. Fowler, H. W.—Zoological Results of the Third De Schauensee Siamese Expedition, Part I.—Fishes. *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVI, p. 101 (1934).

Meinken (1932) has figured 2 interesting variations." Unfortunately Meinken's[1] article is not available in Calcutta so I am unable to judge the precise specific limits of the species figured by him. Suvatti[2] has recorded *A. kuhlii* from two other localities in Siam Khau Sabap, Canthaburi and Nong Kho, S. E. Siam.

There are many records of the occurrence of *A. kuhli* from the Malay Peninsula (*vide* Fowler, H. W.—A List of the Fishes known from Malaya. *Fisheries Bull. Singapore,* I, p. 53, 1938; Selangor, Negri Sembilan, Malacca, Singapore, Seletar River). Herre and Myers[3] recorded that "A typical specimen 55 mm. long was taken in the outlet of Lake Chin Chin, near Jasin, Malacca, and one of 19 mm. from the Mawai District, Johore." Later Herre[4] found "Forty specimens, 24 to 56 mm. in length, from a roadside ditch in the Mawai District, Johore, and 4 from 34 to 47 mm. in length, from a stream 5 miles north of Kota Tinggi, Johore." As indicated above, Herre's specimens of *A. kuhli* from Johore have now been designated as *A. semicinctus,* but what species, subspecies or races are represented among the specimens from other localities it is not possible to say, though there is a probability that all the Siamese and Malayan examples are referrable to *A. semicinctus.*

Herre made the following observations regarding the habitat and colouration of his *A. kuhli* from Johore:—

> "This species is subject to a good deal of variation in depth, and preserved specimens are apt to be good deal thicker than in life. Their pinkish colour is conspicuous in active living specimens, contrasting with their dark transverse bars. They occur in great abundance in ditches containing only a few inches of water and entirely filled with dense mat of filamentous green algae. In such places they have plenty of food and are amply protected from enemies and the direct heat of the sun."

Acanthophthalmus (Cobitophis) anguillaris Vaillant.

1916. *Acanthophthalmus anguillaris,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* III, p. 35, fig. 15.
1934. *Acanthophthalmus anguillaris,* Fowler, *Proc. Acad. Nat. Sci. Philadelphia,* LXXXVI, p. 103.
1940. *Cobitophis perakensis,* Herre, *Bull. Raffles Mus. Singapore,* No. 16, p. 8, pl. ii.

I have examined a paratype of Herre's *Cobitophis perakensis,* 54 mm. in total length. Herre distinguished it from the

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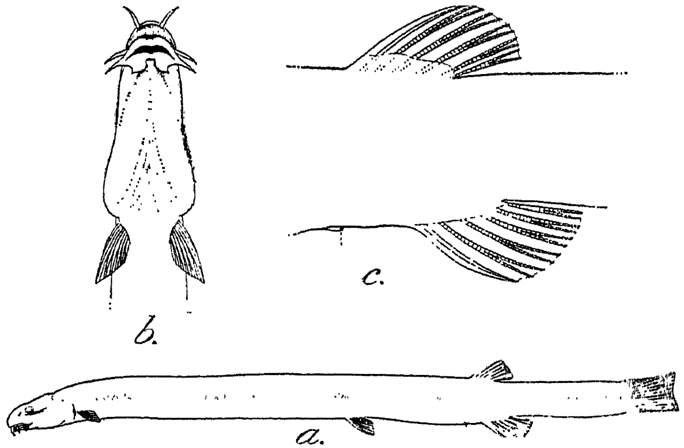
1. Meinken, H.—*Acanthophthalmus kuhli* (C. et. V.). *Bl. Aquarienkunde Stuttgart,* XLIII, pp. 257–259, 1 fig. (1932).
2. Suvatti, C.—*Index to Fishes of Siam,* p. 58 (Bangkok: 1936).
3. Herre, A. W. C. T. and Myers, G. S.—A Contribution to the Ichthyology of the Malay Peninsula. *Bull. Raffles Mus. Singapore,* No. 13, p. 65 (1937).
4. Herre, A. W. C. T.—Additions to the fish fauna of Malaya and notes on rare or little known Malayan and Bornean fishes. *Bull. Raffles Mus. Singapore,* No. 16, p. 33 (1940).

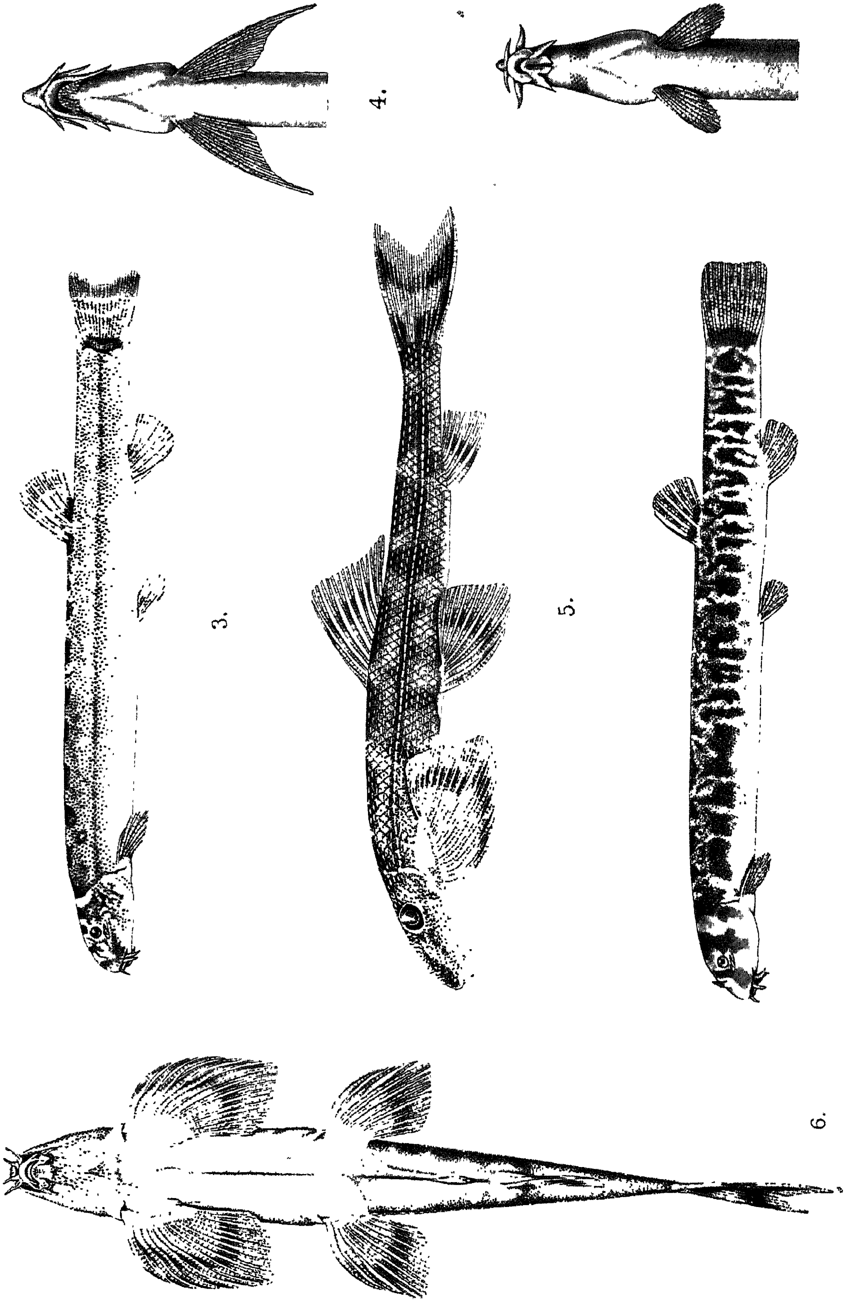
closely allied species "in the position of the dorsal, and in proportions". A study of the literature has shown that there is little difference between *C. perakensis* and *Acanthophthalmus anguillaris*. In both the species the dorsal and the anal fins are situated opposite to each other. In the former the anal origin is stated to be opposite the first divided ray of the dorsal, which ends opposite the second divided anal ray. The dorsal fin of *A. anguillaris*, as noted for the type-specimen, is more extensive,



Text-fig. 2.—*Acanthophthalmus (Cobitophis) anguillaris* Vaillant.
a. Lateral view of a paratype of Herre's *Cobitis perakensis*. × 1½; *b*. Ventral surface of head and anterior part of body of same. × 4½; *c*. Lateral view of a portion of the body in the region of the dorsal and anal fins showing their relative positions. × 5.

for the end of the dorsal is stated to be above the end of the anal. In the specimen examined by me the respective positions of the two fins correspond with Herre's description, though in his figure of *C. perakensis* the dorsal is shown as extending to above the end of the anal. As regards body proportions, much significance cannot be attached in such small, eel-like forms; they are subject to considerable variations both with localities, nature of substratum, availability of food and the sizes of the specimens examined. Unfortunately Fowler did not discuss the range of variation of different characters of this species though he had 392 specimens from Siam for examination.

The known range of distribution of *A. anguillaris*, Borneo and Siam, also points to its possible occurrence in the Malay Peninsula. The morphological characters discussed above and the geographical distribution of the species clearly indicate that



Cobitidæ and Homalopteridæ from the Malay Peninsula.

B. N. Bagchi & A. K. Mondul del

Herre's *Cobitophis perakensis* is identical with *A. anguillaris*. From the Malay Peninsula, specimens of *A. anguillaris* have hitherto been obtained from the lake above the Chenderoh Dam in Upper Perak.

Acanthophthalmus (Cobitophis) muraeniformis de Beaufort (Plate V, figs. 1–3)

1933. *Acanthophthalmus (Cobitophis) muraeniformis*, de Beaufort, *Bull. Raffles Mus. Singapore*, No. 8, p. 32.
1936. *Acanthophthalmus (Cobitophis) muraeniformis*, Tweedie, *ibid.*, No. 12, p. 19.
1937. *Acanthophthalmus muraeniformis*, Herre and Myers, *ibid.*, No. 13, p. 65.
1938. *Acanthophthalmus muraeniformis*, Fowler, *Fisheries Bull. Singapore*, No. 1, pp. 53, 250.

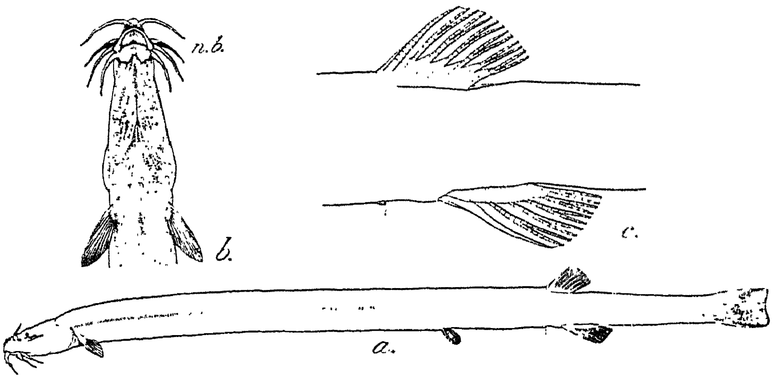
Acanthophthalmus muraeniformis is a very characteristic loach and can readily be distinguished by its colouration, the number of barbels, the position of the dorsal fin and the relative length of the paired fins. Herre and Myers have shown that the depth of the body and the length of the head are subject to considerable variation. I have examined three specimens from Kota Tinggi, Johore and 25 from Kuala Tahan, Pahang. In one of the specimens from the former locality and in all the specimens from Pahang the colour markings are not so well developed and the body is more finely mottled with a somewhat darker band along the lateral line. In these specimens the broad, brown blotches on the back are sometimes diffuse or absent. There is, however, a black spot in the axil of the pectoral fin and a black band at the base of the caudal fin. In some of the specimens there may be 2 pairs of labial barbels. The caudal fin is slightly emarginate in a number of specimens.

Acanthophthalmus (Cobitophis) vermicularis Weber & de Beaufort

1916. *Acanthophthalmus vermicularis*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 34.

In the collection under report, there are two specimens, about 80 mm. in length, which I refer to *Acanthophthalmus vermicularis;* these examples agree very closely with the description of the species as given by Weber and de Beaufort, except that they are provided with well-marked nasal barbels. It is likely that these appendages may have been overlooked in the type-specimen, which was collected in Sumatra. Our specimens were obtained from Kuala Tahan, Pahang and Ulu Lebir, Kelantan. This species can readily be distinguished from *A. anguillaris* by the presence of the nasal barbels and by the position of the dorsal fin in relation to the anus and the anal fin. Among the species hitherto included in the genus *Acanthophthalmus*, *A. vermicularis* is unique in possessing nasal

barbels. According to some authors it is a good character for separating genera, but I regard it as of specific value only.



Text-fig. 3.—*Acanthophthalmus (Cobitophis) vermicularis* Weber and de **Beaufort.**
a. Lateral view of a specimen from Kuala Tahan, Pahang. × 1⅙; *b.* Ventral surface of head and anterior part of body of same. × *ca* 3; *c.* Lateral view of a portion of the body in the region of the dorsal and anal fins showing their relative positions. × 4.

Acanthophthalmus vermicularis has hitherto been known from Sumatra; it is recorded here for the first time from the Malay Peninsula.

Acanthopsis choirorhynchus (Bleeker)

1916. *Acanthopsis choirorhynchus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 25, figs. 8, 9.
1938. *Acanthopsis choirorhynchus*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 54.
1940. *Acanthopsis choirorhynchus*, Herre, *Bull. Raffles Mus. Singapore*, No. 16, p. 33.

I have examined two specimens of *Acanthopsis choirorhyn-* from Jalong, Perak, 148 mm. and 162 mm. in length respectively. This species is widely distributed in Sumatra, Java, Borneo, Malay Peninsula, Siam, Annam and Burma. From the Malay Peninsula it has been recorded from several localities (*vide* Fowler, 1938).

Botia hymenophysa (Bleeker)

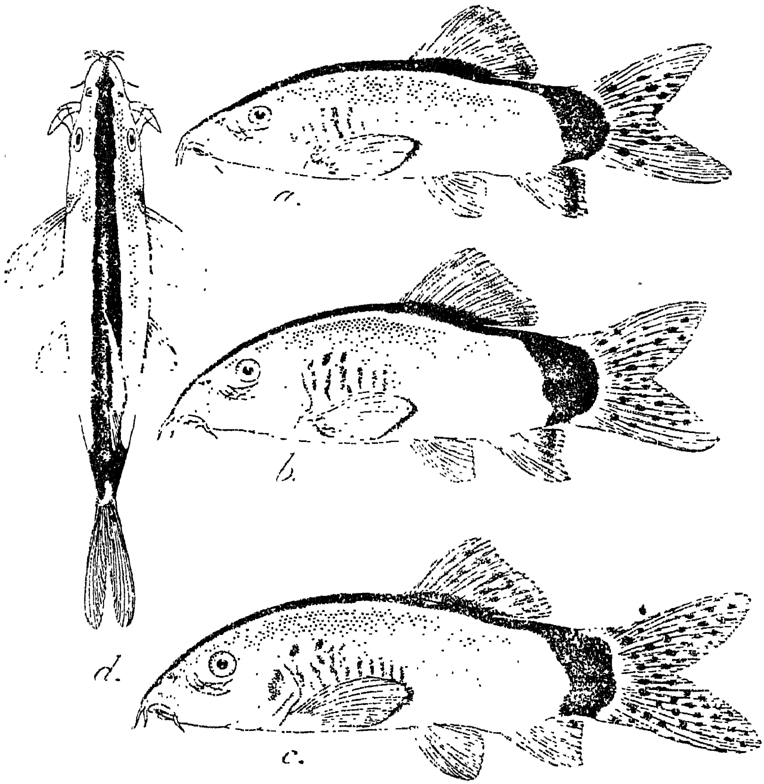
1916. *Botia hymenophysa*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 24.
1936. *Botia hymenophysa*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 19.
1938. *Botia hymenophysa*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 54.

I have examined two fine specimens of *Botia hymenophysa*, 160 mm. and 168 mm. in length respectively, from the King

George V National Park, F.M.S., and a young example, 92 mm. in length from Tasek Bera, Pahang. The young specimen is somewhat lighter in colour, but the dark edges of the lateral bands are very distinct. In the colouration of the dorsal and caudal fins also, this specimen differs from the other two larger examples. The range of distribution of *B. hymenophysa* extends from Java, Sumatra, Borneo, through the Malay Peninsula to Siam.

Botia modesta Bleeker

1922. *Botia modesta*, Hora, *Rec. Ind. Mus.*, XXIV, p. 317.
1923. *Botia modesta*, Hora, *Journ. Nat. Hist. Soc. Siam*, VI, p. 148.
1931. *Botia horae*, H. M. Smith, *Proc. U. S. Nat. Mus.*, LXXIX, art. 7, p. 4, fig. 2.
1934. *Botia modesta*, Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVI, p. 101, figs. 53, 54.



Text-fig. 4.—*Botia modesta* Bleeker. × 2/3.
a., *b.*, *c.* Three specimens of different sizes showing variation in colouration; *d.* View of the longest specimen from the dorsal surface.

Botia modesta is represented in the collection by three specimens, 66 mm. to 77 mm. in length; they were collected from the King George V National Park at Kuala Tahan, Pahang. These specimens are characterised by a black dorsal band which runs from the tip of the snout to the base of the caudal fin where it joins a broad band in front of the base of the caudal fin. These black areas are encircled by narrow whitish areas while the general body colour is grayish. The sides of the body above the pectoral fins are marked with a variable number of short, narrow bands. The dorsal fin is provided with a row of spots in the middle and the tip of the anal fin is blackish. The caudal fin is covered with numerous, black, rounded spots.

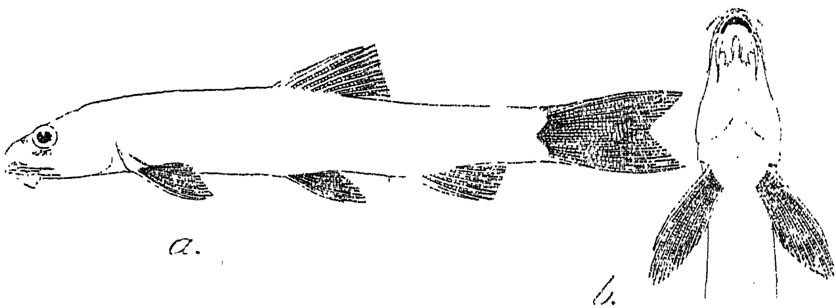
The colouration of *B. modesta* appears to be very variable as already pointed out by Fowler, and I agree with him that *B. horae* Smith represents only a juvenile form of *B. modesta*. In the Malayan examples the colour pattern is quite different from what has been described so far.

B. modesta has hitherto been known from Siam; it is recorded here from the Malay Peninsula for the first time.

Lepidocephalus furcatus de Beaufort

1933. *Lepidocephalus furcatus*, de Beaufort, *Bull. Raffles Mus. Singapore*, No. 8, p. 32.
1938. *Lepidocephalus furcatus*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 54.

I have examined a typical, partially desiccated, specimen of *Lepidocephalus furcatus;* it is about 33 mm. in length. This species, as remarked by de Beaufort, is remarkable in possessing a forked tail (the caudal fin is normally truncate in the species of this genus). In *L. irrorata* Hora[1], commonly found in the



Text-fig. 5.—*Lepidocephalus furcatus* de Beaufort.
a. Lateral view of a typical specimen. × 2½; *b.* Ventral surface of head and anterior part of body of same. × 3½.

1. Hora, S. L.—Fish and Fisheries of Manipur with some observations on those of the Naga Hills. *Rec. Ind. Mus.*, XXII, p. 196, pl. ix, fig. 5.

lake and rivers of the Manipur Valley, Assam, the tail is not forked to the same extent as in *L. furcatus,* but is distinctly concave. Besides the nature of the caudal fin, in the marking on the fins also the two species are somewhat similar.

Six specimens of *L. furcatus* were obtained from the Bukit Merah Reservoir, Perak. So far the species is endemic to the Malay Peninsula.

Lepidocephalus hasselti (Cuvier & Valenciennes)

1916. *Lepidocephalus hasselti,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* III, p. 29.
1940. *Lepidocephalus hasselti,* Herre, *Bull. Raffles Mus. Singapore,* No. 16, p. 33.

Though *Lepidocephalus hasselti* has been known to occur in Sumatra and Java on the one hand and Tenasserim and Siam[1] on the other, it was only recently recorded by Herre from the Malay Peninsula (Mawai District, Johore). I have examined 9 specimens, 30 mm. to 40 mm. in length, from Sauk, Upper Perak and Pengkalan Chepah, Kota Bharu, Kelantan. The five specimens from Perak had previously been examined and correctly determined by Dr. Herre.

Lepidocephalus macrochir (Bleeker). (Plate V, fig. 4)

1916. *Lèpidocephalus macrochir,* Weber and de Beaufort, *Fish. Indo-Austral. Archipel.,* III, p. 29.
1933. *Acanthophthalmus pahangensis,* de Beaufort, *Bull. Raffles Mus. Singapore,* No. 8, p. 31.
1938. *Acanthophthalmus pahangensis,* Fowler, *Fisheries Bull. Singapore,* No. 1, p. 54.

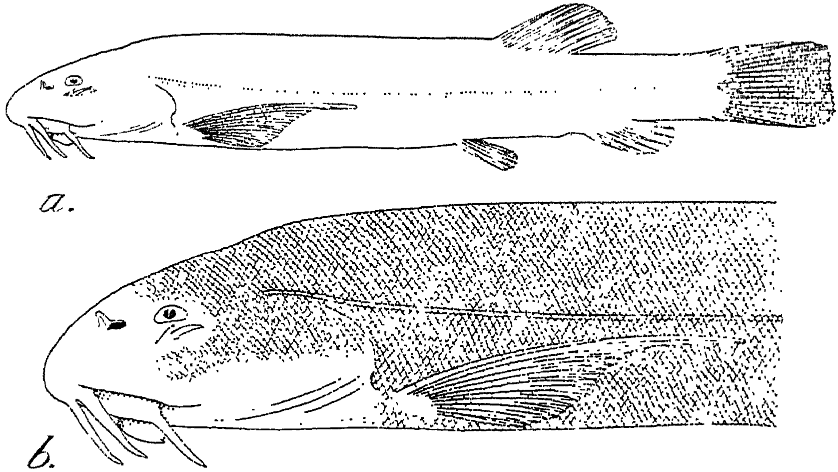
In discussing the systematic position of his new species, *Acanthophthalmus pahangensis,* de Beaufort remarked:

> "In the position of the dorsal this species comes near to *A. kuhli* and *A. borneensis.* It differs from both, besides in the fin formulae, in the long falcate pectorals. In this respect it agrees with *Lepidocephalus macrochir,* with which species it has more points of resemblance. It differs however by having the head scaleless, the chief difference between the two genera *Lepidocephalus* and *Acanthophthalmus.*"

A. pahangensis is known from a single specimen, 44·5 mm. in length; it was obtained from a "fish-drive" off Mentakab, Pahang River. I have carefully studied this specimen and found it to be covered with a thick coating of whitish, mucous substance. When this covering of mucus was removed with the help of fine needles and brush, scales were found to be present on the head in the region below and behind the eyes. Thus there is no doubt that the fish belongs to the genus *Lepidocephalus* Bleeker. The falcate pectorals characterise it as *L. macrochir.*

1. Suvatti, C.—*Index to Fishes of Siam,* p. 60 (Bangkok, 1936).

Attention may be directed to the fact that the proportions given by de Beaufort for his *A. pahangensis* differ considerably from those given for *L. macrochir* by Weber and de Beaufort.



Text-fig. 6.—*Lepidocephalus macrochir* (Bleeker).
a. Lateral view of the type-specimen of *Acanthophthalmus pahangensis* de Beaufort (= *L. macrochir*). × 2¼; *b.* Lateral view of head and anterior part of body showing distribution of scales on the head. × 4½.

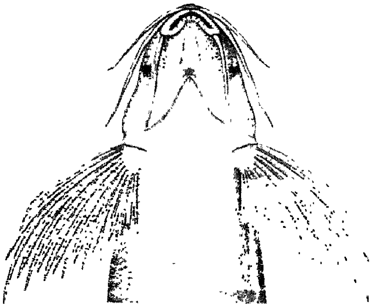
These differences may be due to the fact that the only known specimen of the former is about half the normal size attained by the latter.

L. macrochir has so far been known from Java and Sumatra; it is recorded here for the first time from the Malay Peninsula.

? Nemachilus fasciatus (Cuv. & Val.). (Plate VI, fig. 1)

1936. *Nemachilus fasciatus*, Tweedie, *Bull. Raffles Mus. Singapore*, No. 12, p. 19.
1938. *Nemacheilus fasciatus*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 250.
1940. *Nemachielus fasciatus*, Herre, *Bull. Raffles Mus. Singapore*, No. 16, p. 33.

I have examined a specimen from Johore determined by de Beaufort as *Nemachilus fasciatus;* it is stated to have been collected in 1898. At the present time it is badly damaged and is in a very poor state of preservation. It is very difficult to be sure of its exact position, but its very long barbels and distinct scales indicate its resemblance to *N. selangoricus*. Tweedie and Fowler have based their records of the occurrence of *N. fasciatus* in the Malay Peninsula on de Beaufort's determination of this specimen.



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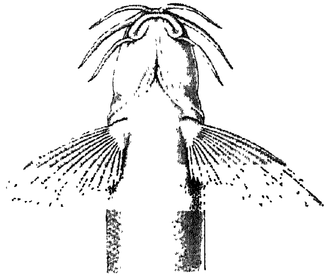

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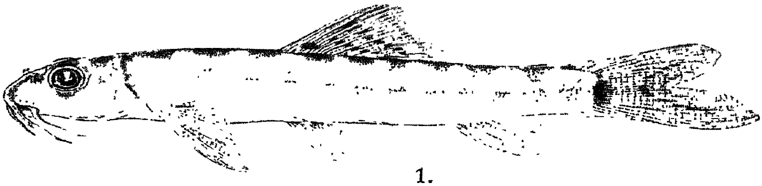

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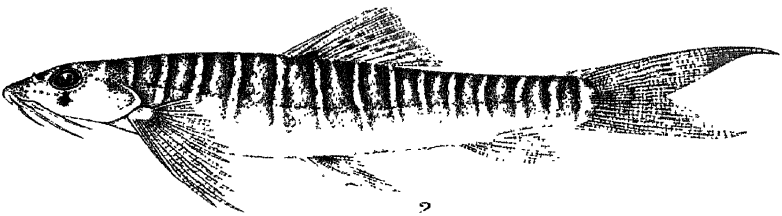

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4.

B. N. Bagchi &
A. K. Mondul del.

Nemachilus from the Malay Peninsula.

Recently Herre assigned a specimen, 29 mm. long, taken from a stream 5 miles north of Kota Tinggi, Johore, to *N. fasciatus*. So small a specimen of *Nemachilus* is generally difficult to determine specifically as the adult colouration and other features usually develop at a somewhat later stage.

Among the 3 specimens from Mawai District, Johore, determined by Herre as *N. selangoricus* there are two, 44 mm. in length, which do not belong to that species, but exhibit some similarity with *N. fasciatus*. I figure a specimen in which the caudal fin is abnormal, to show the main features of these examples but, in the absence of adult material, I do not wish to comment on their specific position, and for the time being refer them doubtfully to *N. fasciatus*.

N. fasciatus is common in Sumatra, Java and Borneo, and has also been recorded from Siam.[1] In view of its distribution there is every probability of its occurrence in the Malay Peninsula also.

Nemachilus masyæ Smith. (Plate VI, fig. 4, 5)

1933. *Nemacheilus masyae*, Smith, *Journ. Siam Soc. Nat. Hist. Suppl.*, IX, p. 58, pl. i, fig. 3, text-fig. 3.
1934. *Nemacheilus masyae*, Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVI, p. 108.

Nemachilus masyæ is represented by a single, mature, female specimen about 80 mm. in length (62·5 mm. without caudal) ; it was collected from the King George V National Park. In all the salient features the specimen agrees with the description of the species as given by Smith. As noticed by Smith in the case of the two specimens obtained by Mr. Havmoller from a pond in Ronpibun, the tips of the rays of the pectoral fins are produced into long filamentous processes and the pelvic and the anal fins have fimbriated edges. Attention has already been directed by Smith and Fowler to a certain amount of variation in the colouration of the species.

Nemachilus masyæ is widely distributed in Siam and is recorded here from the Malay Peninsula for the first time.

Nemachilus selangoricus Duncker. (Plate VI, figs. 2, 3)

1904. *Nemachilus selangoricus*, Duncker, *Mitteil. Naturhist. Mus. Hamburg*, XXI, p. 175.
1937. *Nemacheilus selangoricus*, Herre and Myers, *Bull. Raffles Mus. Singapore*, No. 13, p. 65.
1938. *Nemacheilus selangoricus*, Fowler, *Fisheries Bull. Singapore*, No. 1, p. 54.
1940. *Nemacheilus selangoricus*, Herre (in part), *Bull. Raffles Mus. Singapore*, No. 16, p. 34.

The precise specific limits of *Nemachilus selangoricus* are not well defined and unfortunately the species has not been

[1] Suvatti, C.—*Index to Fishes of Siam*, p. 57 (Bangkok: 1936).

figured so far. Recently Herre redescribed the species from several fresh examples obtained from Borneo, Singapore and Johore, but from an examination of a part of the material determined by him as *N. selangoricus* I have found that he had mixed up two distinct forms under this name. According to Duncker's brief description of the species the following are the important diagnostic features of *N. selangoricus*:—(i) The six barbels, 4 rostral and 2 maxillary, are well developed; they almost reach the gill-openings. (ii) The caudal fin is deeply forked. (iii) The body is marked with 10–12 dark, vertical bands which are separated by very narrow interspaces of a light ground colour. The bands extend up to about half of the distance below the lateral line and sometimes they coalesce or become irregularly divided up, particularly below the anterior end of the dorsal fin. The dorsal fin is provided with three rows of spots and there is also a black suborbital spot.

Judging from the characters enumerated above, I am able to refer to *N. selangoricus* 4 specimens collected from the following localities:—

		Standard length
Singapore	2 specimens	44·0, 48·5 mm.
Rengam, Johore ..	specimen	52·0 mm.
Mawai Dist., Johore	specimen	28·0 mm.

All the specimens examined by me are females and are, therefore, devoid of the small, stumpy, suborbital process described by Duncker in his specimens. The most characteristic feature of the species is its colouration which in some respects resembles that of *Nemachilus savona* (Ham.) and *N. dayi* Hora[1]. In *N. selangoricus* the pale, narrow, vertical bars are generally bordered by deep black streaks. In the specimen from Rengam, Johore, which is a female full of eggs, the rays of the pectoral and to some extent of the pelvic fins are produced beyond the membrane into filamentous processes as has been noticed above in the case of *N. masyæ*. The lobes of the caudal fin are greatly produced, the upper lobe is considerably longer than the lower. The body is covered with small, but fairly distinct, scales.

Nemachilus selangoricus is a small loach in which the head and the anterior part of the body are somewhat depressed, while the tail region is compressed from side to side. The head is short and bluntly pointed; its length is contained from 4·6 to 4·7 times in the standard length. It is somewhat wider than high. The height of the head is contained from 1·5 to 2·0 times and its width from 1·4 to 1·8 times in its length. The eyes are

1. Hora, S. L.—Loaches of the genus *Nemachilus* from Eastern Himalayas, with the description of a new species from Burma and Siam. *Rec. Ind. Mus.*, XXXVII, pp. 56, 57 (1935).

of moderate size and are placed at the sides more or less in the middle of the head near the dorsal surface; they are not visible from the ventral surface. The diameter of the eye is contained from 3·4 to 3·5 times in the length of the head, from 1·0 to 1·2 times in the interorbital width and from 1·1 to 1·2 times in the length of the snout. The nostrils are close to the anterior border of the eye; the anterior nostril is tubular with the posterior wall of the tube produced into a conical flap. The mouth is small, inferior, lunate and horizontal; it is situated only slightly behind the tip of the snout and is bordered by fleshy and continuous lips. The lower lip is slightly interrupted in the middle and the two portions are crenulated in this region. The lateral line tubes are continued on the head and extend both above and below the eyes. The gill-openings do not extend beyond the base of the pectoral fins. There are 3 pairs of well-developed barbels, 2 pairs rostral and one pair maxillary. The outer rostral barbels are the longest; these as well as the maxillary barbels miss the gill-openings by a short distance.

The depth of the body is contained about 5·5 times in the standard length but in a female full of eggs it is only 4·1 times. The caudal peduncle is well formed; its least height being contained from 1·2 to 1·4 times in its length. The scales are small, distinct and imbricate; they cover the entire body except the ventral surface between the pectoral fins. The lateral line is complete.

The dorsal fin commences in advance of the pelvics and the anterior point of its origin is considerably nearer the tip of the snout than the base of the caudal fin; its longest ray is almost as long as the head or its base. The paired fins are placed horizontally and are of equal length; in some specimens, however, the rays of the pectoral fin are produced into long filamentous processes. The pectoral does not reach the pelvic fin which does not extend to the anal opening. The origin of the anal fin is considerably nearer the base of the caudal than the commencement of the pelvic fin. The caudal fin is deeply forked; its outer rays are sometimes greatly produced. The upper lobe of the caudal fin is longer than the lower.

Reference has been made above to the characteristic colouration of the species. In smaller specimens a short, prominent black bar is present in the middle of the base of the caudal fin which, like the dorsal, is provided with rows of spots in its proximal half. The first two branched rays of the dorsal fin possess a conspicuous black spot at their bases.

Nemachilus selangoricus is recorded from several localities in the Malay Peninsula, and its occurrence in Borneo (*vide* Herre 1940) requires further confirmation.

Measurements in millimetres

Standard length ..	52·0	48·5	44·0
Length of head ..	11·3	10·3	9·3
Depth of body	12·6	8·6	8·2
Height of head at occiput ..	7·6	6·0	4·7
Width of head ..	8·0	6·5	5·0
Diameter of eye ..	3·3	3·0	2·6
Length of snout ..	4·0	3·5	3·0
Interorbital width ..	3·9	3·3	2·6
Longest ray of dorsal ..	11·3	9·0	10·0
Longest ray of anal ..	7·8	6·8	7·0
Length of pectoral ..	15·5	7·8	12·0
Length of ventral ..	9·6	7·8	8·3
Length of caudal peduncle ..	8·0	6·0	5·8
Least height of caudal peduncle ..	5·5	4·5	5·0

3. Loaches of the family Homalopteridæ

In the fauna of the Malay Peninsula, the Homalopteridæ have so far been represented by three species belonging to the genus *Homaloptera, viz., H. tweediei* Herre, *H. wassinkii* Bleeker and *H. zollingeri* Bleeker. The first species was recently described by Herre from young specimens taken from a shallow rapid creek in the Mawai District, Johore, about 40 miles north of Singapore. I have examined 3 specimens of *H. tweediei.* With regard to the possible further distribution of this species reference may here be made to the remarks made by me[1] on the species represented by two undetermined specimens of *Homaloptera* from Perak preserved in the collection of the Zoologisches Museum der Universität, Berlin. It was stated:

> "In general facies it corresponds to the large-eyed species of *Homaloptera* and is characterised by the possession of fewer rays in the pectoral fins. The pectoral fin is provided with 12–13 rays of which 4–5 anterior rays are simple. The ventral fin possesses 8 rays of which 2 anterior rays are simple. The air-bladder is like that of *H. rupicola* enclosed in two fairly large, thin-walled bony capsules. These specimens probably represent a new species but as I did not take the full description of the specimens during my visit to Berlin I am now unable to characterise the species and, therefore, refrain from giving it a new name."

Homaloptera tweediei also belongs to the group of large-eyed species and is characterised by fewer rays in the pectoral fins. In a very young specimen, about 21 mm. in length, the air-bladder was found enclosed in two fairly large, thin-walled bony capsules. Thus there seems every probability that the Perak specimens in the Berlin Museum belong to *H. tweediei,* but one cannot be certain without a further examination of the material. The relatively large size of the scales, the pectorals extending beyond the commencement of pelvics and the naked ventral surface up to the pelvic fins are some of the other important diagnostic features of *H. tweediei.* The species is so far endemic to the Malay Peninsula.

The earliest known species of *Homaloptera* from the Malay Peninsula is *H. wassinkii;* it was doubtfully recorded by

1. Hora, S. L.—Classification, Bionomics and Evolution of Homalopterid Fishes. *Mem. Ind. Mus.,* XII, p. 288 (1932).

Duncker[1] from Kuala Lumpur, but Weber and de Beaufort[2] did not include this record among the list of habitats of this species. In 1932, I[3] made the following remarks on two young specimens from Kuala Lumpur, labelled as *H. wassinkii,* in the collection of the Amsterdam Museum:

> "They are *Helgia*-like in appearance and are provided with large eyes. The head is long and narrow and the body is considerably elevated. The pectorals extend beyond the commencement of the ventrals. It is very difficult to be certain of the determination of these specimens."

However, a definite record of the occurrence of *H. wassinkii* in Malayan waters (Perak) is published in this journal (No. 17, p. 5). Besides the Malay Peninsula, this species is known from Sumatra, Java and Borneo.

Homaloptera zollingeri is more widely distributed and though its occurrence in the Malay Peninsula was recorded only recently (Hora, *loc. cit.*, No. 17, p. 6), it was already known from Sumatra and Java on the one hand and Siam on the other.

In the fresh material that I have examined now, I have found 4 specimens of *H. zollingeri* and 19 specimens of a new species of *Homaloptera.* The four Malayan species of *Homaloptera* can be distinguished by the following key:—

Key to the Malayan species of *Homaloptera*

I. Origin of dorsal behind origin of ventrals; lateral line 41–47 .. .. *H. wassinkii.*
II. Origin of dorsal opposite to or before origin of ventrals—
  A. Scales smooth, without keels; lateral line 36–37 .. .. *H. tweediei.*
  B. Scales provided with prominent keels—
    1. Lateral line 45–48; abdomen scaly with the exception of the space between pectorals .. .. *H. zollingeri.*
    2. Lateral line 57–60; abdomen to base of anal fin totally naked .. *H. leonardi,* sp. nov.

Homaloptera leonardi, sp. nov. (Plate V, figs. 5, 6)

D. 3/8; A. 2/5; P. 6/10–11; V. 2/8; C. 18.

Homaloptera leonardi is a small and slender loach, in which the head and body are greatly depressed but the tail region is slightly compressed and whip-like; the dorsal profile is slightly arched but the ventral surface is flattened and horizontal up to the commencement of the anal fin. The head tapers anteriorly, but its apex is broadly pointed and somewhat trenchant. The head is relatively longer in smaller individuals; its length is contained from 5·3 to 6·0 times in the total length

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1. Duncker, G.—Die Fische der malayischen Halbinsel. *Mitteil. Naturhist. Mus. Hamburg,* XXI, p. 175 (1904).
2. Weber, M. and de Beaufort, L. F.—*The Fishes of the Indo-Australian Archipelago,* III, p. 10 (Leiden: 1916).
3. Hora, S. L.—Classification, Bionomics and Evolution of Homalopterid Fishes. *Mem. Ind. Mus.,* XII, p. 280 (1932).

and from 4·3 to 4·8 times in the length without the caudal. The width of the head is almost equal to its length in front of the posterior border of the eye and its height at occiput is about half the length of the head. The snout is broad, flat and obtusely pointed; it is slightly longer than half the length of the head and in consequence the eyes are situated entirely in the posterior half of the head. The eyes are dorso-lateral in position and are of moderate size; the diameter of the eye is contained from 3·6 to 4·1 times in the length of head, from 2·0 to 2·2 times in the length of the snout and from 1·0 to 1·3 times in the interorbital width. In the smaller specimens the eyes are proportionately larger and the interorbital space is smaller and more convex. The nostrils are situated slightly in front of the eyes, and are separated by a well-marked membranous flap. The mouth is inferior, small, lunate and horizontal; it is bordered by thick, plain lips which are continuous at the angles of the mouth. The lower lip is interrupted in the middle and the jaw is left bare. The middle portion of the lower lip is produced backwards into two prominent ridges. The rostral groove is fairly well marked and is continued round the angle of the mouth but is widely interrupted in the middle. The barbels are short and stumpy. The lower jaw is shovel-like and is provided with a sharp rasping edge.

The body is relatively deeper in smaller individuals; its height is contained from 8·7 to 12·0 times in the length and from 8·0 to 9·6 times in the length without the caudal. The caudal peduncle is long and narrow; its least height is contained from 2·6 to 3·0 times in its length. The body is covered with small, carinate scales, those on the dorsal surface are somewhat larger in size. There are 57 to 60 scales along the lateral line, 6½ rows above it to the base of the dorsal fin and 6 rows between it to the origin of the pelvic fins; the number of predorsal scales is about 18. The head and the ventral surface of the body up to the origin of the anal fin are absolutely naked.

The commencement of the dorsal fin is slightly in advance of that of the pelvics and is slightly nearer to the tip of the snout than to the base of the caudal fin; it is somewhat rounded and its height is considerably greater than the depth of the body below it. The pectoral fins are pedunculate, horizontal and fan-shaped; they are longer than the head but do not reach the pelvic fins; they are provided with 6 unbranched and 10–11 branched rays. The pelvic fins are similar to the pectorals but are much shorter; they do not extend as far as the anal opening; they are provided with 2 unbranched and 8 branched rays. The anal fin is short, but it is longer than the depth of the body. The caudal fin is longer than the head and is deeply forked with the lower lobe longer than the upper; its length is contained from 3·7 to 4·4 times in the standard length. Some of the outer rays in both the lobes are closely applied together so as to form oar-like structures.

The body is marked with six black saddle-shaped patches on the dorsal surface which may extend to the sides as far as the lateral line; they are separated by narrow whitish bands. In between the black bands on the sides along the lateral line is another row of spots and this is followed by another series of spots, some of which extend to the ventral side. The head is dark above and light below. The ventral surface of the body is dull white. All the fins are marked with varying numbers of bands.

Locality:—Kuala Tahan, Pahang (King George V National Park).

Type-specimen:—F. $\frac{13213}{1}$, *Zoological Survey of India, Indian Museum, Calcutta.*

Remarks.—In general facies *H. leonardi* is a *Balitora*-like fish and from its totally naked ventral surface, greatly flattened body and broad paired fins it seems to be well adapted to live in swift currents. In these characters it bears close resemblance to *H. tate-regani* Popta[1], but differs from it in having fewer scales along the lateral line (57 to 60 *versus* 64), more predorsal scales (18 *versus* 14), fewer rays in the pectorals (6/11 *versus* 8/12), larger eyes (3·6 to 4·1 *versus* 7 times in length of head), extent of pectorals (widely apart *versus* reaching pelvics) and colouration. Attention may, however, be directed to the similarity in the form of the rostral groove and lips[2] in the two species. *H. tate-regani* is so far known from a single specimen, 85 mm. long, collected from the river Bŏ, Borneo.

The new species of *Homaloptera* is named after Mr. G. R. Leonard, Superintendent of the King George V National Park, in slight recognition of the help rendered by him in the collection of fishes from Kuala Tahan, Pahang.

Measurements in millimetres

Total length	57·0	54·0	50·0	49·0	46·0	44·0	39·5	35·0
Standard length	45·0	44·0	40·0	39·0	36·5	35·6	31·5	28·0
Length of caudal ..	12·0	10·0	10·0	10·0	9·5	9·4	8·0	7·0
Length of head	9·5	9·0	8·3	8·5	8·0	8·0	7·0	6·5
Depth of body	5·0	5·0	4·2	4·1	4·5	4·5	3·9	3·5
Diameter of eye	2·3	2·3	2·2	2·1	2·1	2·0	1·9	1·8
Length of snout	5·0	5·0	4·8	4·7	4·8	4·8	4·0	3·7
Interorbital width ..	3·0	3·0	2·8	2·8	2·8	2·7	2·3	2·1
Distance between snout and origin of dorsal fin ..	21·0	20·0	18·0	18·0	17·0	16·5	15·0	13·2
Length of caudal peduncle	8·0	7·5	6·5	6·0	6·5	6·5	5·8	4·8
Least height of caudal peduncle	2·9	2·8	2·5	2·0	2·3	2·1	2·0	1·8
Length of pectoral fin ..	11·0	11·0	10·0	10·5	9·5	9·0	7·5	7·0
Length of dorsal fin ..	10·5	11·0	10·0	10·0	9·5	9·0	8·0	6·8
Length of ventral fin ..	9·0	9·5	8·0	9·0	7·2	7·0	6·2	5·5
Length of anal fin ..	6·0	6·0	5·0	5·5	5·5	5·3	4·6	4·5

1. Weber M. and de Beaufort, L. F.—*The Fishes of the Indo-Australian Archipelago,* III, p. 19 (Leiden: 1916).

2. For the structure of rostral groove and lips of *H. tate-regani* see Hora in *Mem. Ind. Mus.,* XII, pl. xi, fig. 4 (1932).

Homaloptera zollingeri Bleeker

1916. *Homaloptera zollingeri*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 14.
1940. *Homaloptera zollingeri*, Hora, *supra*, p. 6.

I refer 4 specimens, 55 mm. to 68·5 mm. in length, obtained from the King George V National Park to *Homaloptera zollingeri*. One of the two specimens from Kuala Tahan is much darker in colour and the bands on the body are somewhat obscure. The dorsal surface of the outer rays of its paired fins and the anterior rays of the dorsal and anal fins are dusky. The caudal fin is tipped with white and its upper lobe is provided with a prominent transverse band in the middle.

EXPLANATION OF PLATE V

Cobitidæ and Homalopteridæ from the Malay Peninsula

Fig. 1.—Lateral view of a specimen of *Acanthophthalmus* (*Cobitophis*) *muraeniforms* de Beaufort from Kota Tinggi, Johore, showing typical colour pattern. × 2¼.
Fig. 2.—Ventral surface of head and anterior part of body of same. × 3⅓.
Fig. 3.—Lateral view of a specimen of the same from Kuala Tahan, Pahang, showing a different, lighter colour pattern. × 2¼.
Fig. 4.—Ventral surface of head and anterior part of body of the type-specimen of *Acanthophthalmus pahangensis* de Beaufort (=*Lepidocephalus macrochir*). × 2¼.
Fig. 5.—Lateral view of the type-specimen of *Homaloptera leonardi*, sp. nov. × 2¼.
Fig. 6.—Ventral view of same. × 2¼.

EXPLANATION OF PLATE VI

Nemachilus from the Malay Peninsula

Fig. 1.—Lateral view of a specimen of *Nemachilus fasciatus* (Cuv. & Val.) from Mawai District, Johore. × 2.
Fig. 2.—Lateral view of a specimen of *Nemachilus selangoricus* Duncker from Rengam, Johore. × 1⅓.
Fig. 3.—Ventral surface of head and anterior part of body of same. × 2¼.
Fig. 4.—Lateral view of a specimen of *Nemachilus masyæ* Smith from King George V National Park, F.M.S. × 1⅜.
Fig. 5.—Ventral surface of head and anterior part of body of same. × 1⅓.

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Homalopterid Fishes from Peninsular India.

By

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CALCUTTA

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HOMALOPTERID FISHES FROM PENINSULAR INDIA.

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(Plate VIII.)

In 1920[1], attention was directed to the great confusion that prevailed in the taxonomy of the Indian species of the family Homalopteridae, and three distinct genera were recognised on the basis of the form of the pectoral fins and head, the nature of the lips and barbels, the general shape of the body and the number of rays in the pectoral fins. For the species found in Peninsular India, a new genus *Bhavania* was proposed but unfortunately at that time no attention was paid to the nature of its gill-openings, which in *Bhavania* are restricted above the bases of the pectorals, a feature unique among the Homalopterinae. In my[2] general revision of the Homalopteridae, *Bhavania* was treated as a synonym of *Homaloptera* van Hass., for I had then examined several species of *Homaloptera* in various collections in which the head was broad and rounded like that of *Balitora* and approached the condition found in *Bhavania*. However, in 1937[3], when examining a series of well preserved specimens collected from a stream on the road-side between Kottigehar and Balehonnur, Western Ghats, Mysore State, the gill-opening was found to be very small and restricted above the base of the pectoral fin. The earlier material referred to *Bhavania* was found to be of the same nature. This led me to revive the genus on this very important character.

Recently, Mr. S. Jones, at my request, sent me a small collection of freshwater fishes from Travancore, and in this lot, besides specimens of *Bhavania*, a number of specimens with the gill-openings extending to the ventral surface for a short distance were also found. These examples are remarkable in several respects and for their reception a new genus *Travancoria* is proposed in this paper.

At my request, the Superintendent, Government Museum, Madras, sent me the only specimen of the Homalopteridae in the collection under his charge. The small specimen was collected by Dr. F. H. Gravely at Sivasamudram (alt. 1,500-2,000 ft.), Mysore, in May 1921, and belongs to *Balitora* Gray. In fact, it is closely allied to *B. brucei* Gray, a species of the Assam Hills and the Eastern Himalayas ; but the head is more pointed, the body is not so flattened and the number of unbranched rays in the pectoral fins is less. In these respects, it agrees with the Burmese variety[4] of the species, but till more material of this form becomes available for comparison I propose to describe it as a new variety of *B. brucei*.

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[1] Hora, S. L., *Rec. Ind. Mus.* XIX, pp. 195-207 (1920).
[2] Hora, S. L., *Mem. Ind. Mus.* XII, pp. 274-277 (1932).
[3] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 11 (1937).
[4] Hora, S. L., *Mem. Ind. Mus.* XII, p. 291, pl. xi, fig. 6 (1932).

In view of considerable fresh material having been obtained of *Bhavania* from several parts of Peninsular India, a complete definition of the genus and a revision of its species is also included. In order to define the systematic position of the three South Indian genera, a key to all the known genera of the Homalopterinae is given below.

Key to the genera of the Homalopterinae.

I. Gill-opening small, situated entirely above base of pectoral. (Two anterior rays of pelvic fin simple.) *Bhavania.*

II. Gill-opening of moderate size, extending to ventral surface for short distance.

- A. Two anterior rays of pelvic fin simple.
  - 1. Rostral groove in front of mouth absent or very poorly developed; rostral fold absent or very slightly developed (Lips simple, continuous and without papillae). .. .. .. *Homaloptera.*
  - 2. Deep rostral groove in front of mouth present, overhung by rostral fold.
    - *a.* Seven or more rostral barbels arranged in two series; lips simple, continuous at angles of mouth; lower lip with a separate median portion followed by two prominent papillae. *Travancoria.*
    - *b.* Four rostral barbels in one row; lips, especially the upper strongly papillated; both lips continuous; lower lip not followed by medially situated papillae.
      - i. Two barbels at each angle of mouth; 7-8 anterior rays of pectoral simple; body subcylindrical with flattened ventral surface; snout pointed. .. .. *Sinohomaloptera.*
      - ii. One barbel at each angle of mouth; 9-10 anterior rays of pectoral simple; body greatly depressed and flattened; snout rounded and trenchant. .. .. *Balitora.*
- B. Three or more anterior rays of pelvic fin simple.
  - 1. Pelvics free from each other, not united to form a disc-like structure.
    - *a.* Tail long and slender; least height of caudal peduncle less than diameter of eye; lips fimbriated; 3 barbels at each angle of mouth. .. .. *Lepturichthys.*
    - *b.* Tail stout and deep; least height of caudal peduncle greater than diameter of eye; lips papillated; 2 barbels at each angle of mouth. .. .. *Hemimyzon.*
  - 2. Pelvics united posteriorly to form a disc-like structure. .. .. .. *Sinogastromyzon.*

Of the three genera known from Peninsular India, *Bhavania* is more widely distributed along the Western Ghats having been recorded from the Malabar Hills, Wynaad, Nilgiris, Mysore and Travancore. *Travancoria* is so far known only from the Travancore Hills; it has been found in streams within a radius of about 5 miles of Pampadampara, Peerumedu Taluq, Travancore. *Balitora* is known from the Mysore State, besides north-east Bengal, Chittagong Hill Tract, Assam and Burma.

As a group, the Homalopteridae are extensively distributed in the hills of south-eastern Asia, but in India proper they are found in the hills of Assam and Chittagong, in the Eastern Himalayas as far as the

Tista River System, and in the hills of Peninsular India. In 1932, I (*loc. cit.*, p. 288) was unable to explain how the Homalopteridae spread from the Assam Hills to the Western Ghats, but since then I[1] have adduced evidence to show that the torrential fauna of the north-east spread along the Satpura Trend to south-west. The discovery of another new genus of Homalopterid fishes from South India and the extension of the range of *Balitora* to Peninsular India lend additional support to a large-scale migration of the hill-stream fauna along the route stated above.

In describing a remarkable new genus of Schizothoracine fishes from the Periyar Lake, Travancore, Sundara Raj[2] made remarks on the zoo-geographical significance of his discovery. He has followed the views of Medlicott, Blanford and Oldham[3] and their conclusion that "The only remaining theory, to account for the existence of the same species of animals and plants on the Himalayas and the Hills of Southern India, is depression of temperature." The glacial cold may have helped in the dispersal of the terrestrial fauna from the north to the south, but without direct water communications between the two areas it is difficult to believe that mere depression of temperature could influence the dispersal of aquatic fauna to such distant places as the Himalayas and the hills of Travancore. Moreover, for the dispersal of the torrential Homalopteridae we not only require direct water communication between the Eastern Himalayas (Homalopteridae are not found to the west of the Tista Drainage) and the southern portion of the Western Ghats, but also torrential waters between these two areas, for which one has to postulate a connected chain of hills. This condition is fully satisfied by the Satpura Trend theory advanced by me in recent years and referred to above.

Both *Bhavania* and *Travancoria* are *Balitora*-like in their general facies, nature of paired fins, and the characters associated with the mouth, such as rostral groove, rostral fold, etc. There would thus appear to be a close association of the South Indian forms, and it is probable that these three genera developed along independent lines from a common *Homaloptera*-like ancestral form. The isolation of the Peninsular forms from the main stock of the family for a sufficiently long time seems to have induced in some of them characters which are not found in any other member of the Homalopterinae but are only paralleled among the Gastromyzoninae, which spread more towards east and south from the central highlands of south-eastern Asia.

I wish to express my great indebtedness to Mr. S. Jones, Dr. C. C. John, Prof. A. Subba Rau and Mr. B. S. Bhimachar for their kindness in making collections of freshwater fish for me in Travancore and Mysore. Besides enriching the national collection at the Indian Museum; these have enabled me to describe several new and little known forms from among them. I am also grateful to the Superintendent, Government Museum, Madras, for the presentation of the specimen from

[1] Hora, S. L., *Proc. Nat. Inst. Sci. India* IV, p. 405 (1938).
[2] Raj, B. Sundara, *Rec. Ind. Mus.* XLIII, pp. 213, 214 (1941).
[3] Medlicott, M. A. and Blanford, W. T., *A Manual of the Geology of India*, 2nd ed. (Revised by R. D. Oldham), pp. 13-16 (Calcutta: 1893).

Sivasamudram to the Indian Museum. My thanks are also due to Mr. K. K. Nair for drawing up the tables of measurements and to Messrs. R. Bagchi and B. N. Bagchi for preparing the illustrations.

Bhavania Hora.

1848. *Platycara*, Jerdon (*nec* McClelland), *Madras Journ. Litt. Sci.* XV, p. 333.
1868. *Homaloptera*, Günther (in part), *Cat. Fish. Brit. Mus.* VII, p. 340.
1872. *Homaloptera*, Day (in part), *Journ. As. Soc. Bengal* XLI, p. 28.
1877. *Homaloptera*, Day (in part), *Fish. India*, p. 525.
1889. *Homaloptera*, Day (in part), *Faun. Brit. Ind.* Fish. I, p. 242.
1920. *Bhavania*, Hora, *Rec. Ind. Mus.* XIX, p. 202.
1931. *Homaloptera*, Hora (in part), *Rec. Ind. Mus.* XXXIII, p. 68.
1932. *Homaloptera*, Hora (in part), *Mem. Ind. Mus.* XII, p. 274.
1937. *Bhavania*, Hora, *Rec. Ind. Mus.* XXXIX, p. 11.

The head and the anterior part of the body are greatly depressed, while the tail region is compressed from side to side. The ventral surface up to the anal opening is flattened. The snout is broadly pointed and is provided with more or less trenchant margins. The eyes are dorso-lateral, are provided with free orbital margins and are not visible from the ventral surface. The mouth is small, considerably less than half the width of the head, inferior, transverse and lunate. The lips are fleshy and leave the jaw free and partly uncovered ; they are continuous at the angles of the mouth but the lower lip is divided into one central and two lateral portions ; the middle part is followed by two prominent papillae. In front of the mouth, there is a narrow groove overhung by the rostral fold, from the front margin of which, forming indentations, arise four rostral barbels. Two lappets of the rostral fold curve inwards between the rostral and the maxillary barbels. The rostral groove is continuous with the grooves at the angles of the mouth. The jaws are sharp and covered with a horny substance. The gill-openings are small and restricted to the dorsal surface considerably above the bases of the pectoral fins. The body is covered with small scales which are absent on the ventral surface in front of the anal opening. The scales are provided with short, pointed keels which are continued on the head as series of tubercles. The dorsal and the anal fins are short ; the former commences slightly behind the pelvics. The paired fins are horizontal and extensive ; the pectoral commences slightly behind the eye and extends to the base of the pelvic which extends beyond the anal opening. Between the bases of the pectoral and ventral fins, the body extends outwards and is broadest in front of the bases of the ventrals. The pectoral is provided with 19 rays, of which 6-8 anterior rays are simple. The ventral is provided with 9 rays of which two are simple. The caudal fin is slightly emarginate and some of the outer rays are fused to form oar-like solid structures.

Genotype.—*Platycara australis* Jerdon (=*Bhavania annandalei* Hora).

Relationships.—Among the Homalopterinae, *Bhavania* is the only genus in which the gill-openings are restircted to the dorsal surface of the head and in this respect its development seems to be parallel to several genera of the Gastromyzoninae, such as *Protomyzon*, *Paraprotomyzon*, *Pseudogastromyzon*, *Sewellia*, *Beaufortia*, *Neogastromyzon* and *Gastromyzon*.

Bhavania australis (Jerdon).

Plate VIII, figs. 1-3.

1848. *Platycara Australis*, Jerdon, *Madras Journ. Litt. Sci.* XV, p. 333 (Walliar).
1867. *Homaloptera brucei*, Day (*nec* Gray), *Proc. Zool. Soc. London*, p. 348 (Wynaad).
1868. *Homaloptera brucei*, Günther (*nec* Gray), *Cat. Fish, Brit. Mus.* V, p. 340 (Wynaad: Mr. Day's Collection).
1872. *Homaloptera brucei*, Day (*nec* Gray), *Journ. As. Soc. Bengal* XLI, p. 28 (Wynaad).
1877. *Homaloptera maculata*, Day (*nec* Gray), *Fish. India*, p. 526, pl. cxxii, fig. 2 (Wynaad specimen figured).
1889. *Homaloptera maculata*, Day (*nec* Gray), *Faun. Brit. Ind.* Fish. 1, p. 243 (Wynaad, Nilgiris).
1909. *Homaloptera maculata*, Jenkins (*nec* Gray), *Rec. Ind. Mus.* III, p. 289 (Tenmalai, Western Ghats).
1920. *Bhavania annandalei*, Hora, *Rec. Ind. Mus.* XIX, p. 203, pl. x, figs. 1-3; pl. xi, figs. 5-7 (Travancore, Nilgiris and Malabar).
1920. *Bhavania australis*, Hora, *ibid.*, p. 205. pl. x, figs. 4-6, pl. xi, fig. 8.
1929. *Homaloptera maculata*, Pillay (*nec* Gray), *Journ. Bombay Nat. Hist. Soc.* XXXIII, p. 356.
1936. *Homaloptera maculata*, John (*nec* Gray), *ibid.*, XXXVIII, p. 710.
1937. *Bhavania annandalei*, Hora, *ibid.*, XXXIX, p. 11, text-fig. 4 (Western Ghats, Mysore State).

In 1867, Day recorded *Homaloptera brucei* from the Wynaad hills and assigned *Platycara australis* Jerdon to its synonymy. One of Day's specimens from the Wynaad later served for Günther's description of *H. brucei*[1]. However, in 1877, when Day[2] had obtained specimens of the real *Balitora brucei* Gray from the Darjeeling Himalayas and the hills of Assam, he regarded the Wynaad examples as *H. maculata*, but at the same time included all his earlier references, based on the Wynaad specimens, to *H. brucei* in the synonymy of the real *H. brucei*. Thus a great confusion was created by him in the systematic position and the geographical distribution of the Homalopterid fishes known from the Eastern Himalayas and Peninsular India respectively.

Vinciguerra[3] found considerable difficulty in determining his Burmese examples of *H. brucei*, for he found great discrepancies in Day's earlier and later descriptions of the species and pointed out that the specimens found in the Nilgiri Hills must be regarded as specifically different from the specimens described by Day in the *Fishes of India* as *H. brucei*. In 1920, it was shown by me[4] that Vinciguerra was correct in his analysis of Day's descriptions and a new genus *Bhavania* was proposed for the South Indian forms. Relying mainly on immature specimens, I recognised two species in this genus, but examination of further material has convinced me that the two species are identical, and the earlier name *australis* must, therefore, be used for them.

Unfortunately Jerdon's description of *Platycara australis* is rather vague and applicable to more than one species. He stated: —

"Muzzle depressed, snout somewhat pointed; eyes approximated; body greenish with irregular spots and blotches of brown and red, and a series of white spots along the sides; fins greenish, tinged with sienna red and spotted; caudal with the lobes pointed lower one much the longest; 4 minute cirri at end of snout, and 2 somewhat fleshy short cirri, one in front of and the other behind the mouth. Length about 2½ inches— D.7, A. 6."

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[1] Günther's *Homaloptera maculata* from Assam is in reality *Balitora brucei* Gray.
[2] Day, F., *Fish India*, p. 526, pl. cxxii, fig. 1 (1877).
[3] Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* XXIX, pp. 320-335 (1890).
[4] Hora, S. L., *Rec. Ind. Mus.* XIX, pp. 195-207 (1920).

The nature of the barbels is the only character in the above description which enables this species to be distinguished from the new species described below, for the colouration is more or less similar in the two forms.

In view of considerable fresh material having been obtained from different parts of Peninsular India, the species may now be redescribed as follows :—

D. 2/7-9 ; A. 1/5-6 ; P. 6-8/9-11 ; V. 2/7-8 ; C. 17-18.

Bhavania australis is a *Balitora*-like fish in which the head and the anterior part of the body up to the anal opening are greatly depressed and the ventral surface is flat and horizontal. The tail is broad and compressed from side to side. The dorsal profile is gently arched, the greatest height of the body being in front of the dorsal fin. The head is broad, rounded and almost trenchant ; it is covered with series of short, hard, spine-like growths. The length of the head is contained from 4·37 to 5·42 times in the standard length and from 5·15 to 6·46 times in the total length ; the head is proportionately larger in smaller individuals. The head is almost as broad as long ; its breadth is contained from 1·05 to 1·28 times in its length. The eyes are of moderate size, approximated dorsally and situated in the posterior half of the head ; they are not visible from the ventral surface. The diameter of the eye is contained from 3·88 to 5·59 times in the length of the head, from 1·94 to 3·19 times in the length of the snout and from 1·38 to 2·00 times in the interorbital width ; the eyes are proportionately larger in smaller individuals. The nostrils are situated close to the anterior border of the eye ; the anterior nostril is situated in a flap which covers the posterior nostril. The mouth is small, inferior, semicircular and horizontal ; the gape of the mouth is about one-fifth of the width of the head. The lips are well developed and free from the jaws and leave a considerable portion of the jaws uncovered. Both the lips are continuous at the angles of the mouth but the median part of the posterior lip is separated off from the lateral parts and is followed by two prominent barbel-like papillae. The jaws are hard and covered by a horny substance ; the posterior jaw is rounded and shovel-like. Between the anterior lip and the rostral fold, there is a deep groove which is bifurcated near the origin of the maxillary barbel ; the inner branch is continued round the angles of the mouth while the outer branch is continued outwards and backwards. There are 6 short, stumpy barbels, 4 rostral and 2 maxillary. In between the rostral barbels, the rostral fold is produced into lobes and at the sides lappets are formed which cover parts of the rostral groove. The gill-openings are small, spout-like apertures which are restricted above the base of the pectoral fin. The gill-membranes are broad and thick.

The depth of the body is contained from 6·45 to 9·34 times in the standard length and from 8 to 11 times in the total length ; the body is proportionately more elevated in larger specimens. Between the bases of the pectoral and pelvic fins the body becomes broader posteriorly and is almost as wide as the width of the head. The caudal peduncle is well formed ; its least height is contained from 1·55 to 2·28 times in its length. The body is covered with small scales which are absent

Measurements in millimetres.

—	Kottigehar, Mysore.	Sethumadai Hills, Mysore.				Kallar Stream, South Travancore.				Pampadampara, North Travancore.	
Standard length	27·1	38·1	46·2	71·0	71·6	67·4	71·8	74·2	77·9	54·9	84·2
Length of caudal	4·8	8·1	D.	D.	D.	14·9	16·2	16·2	16·6	D.	17·2
Length of head	6·2	8·4	9·4	13·1	14·1	14·0	14·8	15·1	14·9	11·2	15·7
Width of head	4·9	6·6	8·0	12·0	12·8	12·1	11·6	13·1	13·8	9·2	14·9
Height of head	3·0	3·9	4·8	7·1	6·7	7·1	6·9	6·8	7·4	5·1	8·0
Length of snout	3·1	4·0	5·2	7·8	7·5	7·9	7·9	8·6	8·4	6·2	9·0
Diameter of eye	1·6	1·9	2·0	2·9	2·9	2·6	2·5	2·7	3·0	2·4	3·1
Interorbital width	2·2	2·8	3·0	5·0	5·1	5·0	5·0	5·2	5·5	3·6	5·6
Depth of body	2·9	4·2	6·1	11·0	10·0	9·1	9·2	9·0	10·2	6·0	10·3
Width of body	4·0	5·6	7·9	13·2	12·4	12·9	10·9	12·3	13·1	9·1	13·9
Length of caudal peduncle	3·1	6·4	8·0	10·3	10·6	11·5	10·8	12·8	11·0	9·0	12·7
Least height of caudal peduncle	2·0	2·8	4·1	7·0	6·1	6·0	6·4	7·1	7·4	4·5	6·8
Length of pectoral	7·1	9·7	11·0	16·3	18·7	18·6	19·8	20·0	18·8	14·5	21·6
Length of ventral	4·2	8·2	9·0	15·2	15·9	16·0	17·7	17·8	16·1	12·1	19·3
Longest ray of dorsal	5·4	7·6	9·0	13·0	14·7	13·1	13·9	14·4	14·4	10·7	17·5
Longest ray of anal	3·6	5·6	5·9	9·8	10·0	9·6	10·0	10·8	11·5	8·6	12·4

on the head and on the ventral surface as far as the anal opening. There are about 70 to 75 scales along the lateral line. In some specimens, the scales in the anterior region are slightly keeled. The number of predorsal scales is about 30 and there are about 12 to 15 rows of scales above the lateral line and 9 to 10 below it to the base of the pelvic fins. The anal opening is situated in a shallow groove which runs in the mid-ventral line between the bases of the pelvic and anal fins.

The dorsal fin is short and commences slightly behind the pelvics; it is considerably higher than the depth of the body. The commencement of the dorsal fin is nearer to the tip of the snout than to the base of the caudal fin. The anal is similar to the dorsal and commences nearer to the base of the caudal than to that of the pelvic. The paired fins are broad, wing-like and horizontal. The pectorals commence just behind the eyes, are longer than the head and extend almost to the bases of the pelvics. The pelvic fins are similar to the pectorals and, except in very young specimens, are longer than the head; they may or may not extend as far as the anal opening but are separated from the anal fin by a considerable distance. The caudal fin is forked with the lower lobe considerably longer than the upper; except in the young examples, it is longer than the head.

The basipterygium (Pl. VIII, fig. 2) conforms to the Homalopterinae type; it is devoid of lateral horns and is provided with a lateral foramen. The pharyngeal teeth (Pl. VIII, fig. 3) are uniserial, those in the middle of the slender bone are larger. There are about 13 teeth.

The body and the fins are covered with spots which are irregularly distributed on the body while they form regular rows on the fins. In most of the specimens the dorsal surface is dark so the black spots do not show off well, but in the three specimens from Kallar Stream near Trivandrum the ground colour is considerably lighter and in consequence the spots are very prominent.

Distribution.—In the synonymy, localities from which this species has so far been recorded are given. I have now examined more specimens from the Sethumudai Hills, Mysore; Kallar Stream, near Trivandrum, Travancore, and from streams within a radius of 5 miles of Pampadampara, Travancore. It would thus appear that the species is so far known from the hills in the extreme south of Peninsular India.

Travancoria, gen. nov.

The head and the anterior part of the body are greatly depressed and the ventral surface in front of the anal fin is flattened. The snout is narrowly rounded in front and the fishes resemble the narrow-headed forms of *Balitora brucei* Gray described by me[1] from Burma. The eyes are small, dorso-lateral in position and are provided with free orbital margins; they are not visible from the ventral surface. The mouth is small, inferior, transverse and greatly arched. The lips are full, plain and continuous round the angles of the mouth; the middle part of the posterior lip is separated from the two lateral parts and is followed by two well-developed papillae which may appear as short barbels in

[1] Hora, S. L., *Mem. Ind. Mus.* XII, p. 291, pl. x, fig. 6; pl. xi, fig. 6 (1932).

certain specimens. The anterior jaw is covered by the lip, but the posterior jaw is naked, shovel-like, sharp, strong and covered with a horny substance. In front of the mouth there is a deep groove which is bordered anteriorly by the rostral fold and is continued backwards round the angles of the mouth as well as laterally to the sides of the head; the portion of the groove between the maxillary barbel and the side of the head is partly covered by a hood-like extension of the rostral fold. There are four short and stumpy rostral barbels, and in between these the rostral fold is produced into 3 barbel-like projections. However, the form and arrangement of the barbel-like projections of the rostral fold varies considerably in the specimens examined by me. A pair of similar barbels (maxillary barbels) is situated at the angles of the mouth. The gill-opening is oblique and extends in front of the base of the pectoral fin to the ventral surface for a short distance. The body is covered with small scales which are absent on the head and on the ventral surface in front of the anal fin; some of the anterior scales on the dorsal surface are provided with simple short keels which are continued forwards on the head as series of tubercles. The dorsal and the anal fins are short; the former is almost opposite to the pelvic fins. The paired fins are broad and horizontal. The pectoral fin is pedunculate and commences considerably behind the eyes; it almost reaches the pelvic which extends considerably beyond the anal opening. The body becomes broader posteriorly from behind the bases of the pectorals and is broadest just in front of the pelvics. The pectoral is provided with 15-16 rays of which 6 anterior rays are simple. The pelvic possesses 8-9 rays, of which 2 are simple. The caudal peduncle is well formed. The caudal fin is forked with the lower lobe considerably longer than the upper.

Genotype.—*Travancoria jonesi*, gen. *et* sp. nov.

Relationships.—This remarkable genus is intermediate in certain characters between *Homaloptera* van Hass. and *Balitora* Gray, while it has special features of its own which distinguish it from all the other genera of the Homalopterinae. In the form of the body it resembles certain varieties of *Balitora*, but fewer simple rays in the pectoral fins, simple lips, form of the rostral groove and the barbel-like projections on the anterior rostral fold help to distinguish the two genera. From *Homaloptera*, it differs in the possession of a rostral groove and the additional 3 barbels on the rostral fold. In having a posteriorly forked rostral groove, the new genus resembles *Parhomaloptera* Vaillant which belongs to the Gastromyzoninae. The only other genus of the Homalopterinae in which the pelvic fins are provided with two simple rays is *Sinohomaloptera* Fang; it possesses a rostral groove but its lips are papillated, there are two barbels at each angle of the mouth and the pectoral fins are provided with 7-8 simple anterior rays. In the new genus, the structure of the lips, especially of the lower, the form of the rostral groove, lepidosis, tubercles on the head, and the presence of two papillae behind the lower lip are suggestive of *Bhavania* Hora, but in the latter the gill-openings are restricted above the bases of the pectoral fins, whereas in *Travancoria* they extend in front of the pectoral fin to the ventral surface for a short distance.

Travancoria jonesi, gen. *et* sp. nov.

Plate VIII, figs. 5-9.

D. 2/7-8 ; A. 1/4-5 ; P. 6/9-10 ; V. 2/6-7 ; C. 17 ; L.l. 75-77.

Travancoria jonesi is a well-built loach of moderate size in which the head and the greater part of the body are depressed while the tail is somewhat compressed from side to side. The ventral surface is greatly flattened up to the commencement of the anal fin and thereafter the ventral profile rises gradually to the base of the caudal fin. The dorsal profile is gently arched, the greatest height of the body being in front of the dorsal fin. The head is broadly pointed anteriorly, and is covered with series of short, hard, spine-like growths ; its length is contained from 5·0 to 5·83 times in the standard length and from 5·93 to 6·83 times in the total length. The width of the head is contained from 1·09 to 1·33 times and its height at the occiput from 1·71 to 1·88 times in its length. The eyes are of moderate size, approximated dorsally and situated in the posterior half of the head ; they are not visible from the ventral surface. The diameter of the eye is contained from 4·13 to 5·00 times in the length of the head, from 2·42 to 2·68 times in the length of the snout and from 1·42 to 1·50 times in the interorbital width. The nostrils are situated close to the anterior border of the eye ; the anterior nostril is situated in a flap which covers the posterior nostril. The mouth is small, inferior, semicircular and horizontal ; the gape of the mouth is about one-fifth of the width of the head. The lips are well developed and free from the jaws ; the anterior lip covers the jaw while the posterior lip leaves a considerable part of the jaw bare. Both the lips are continuous at the angles of the mouth, but the median part of the posterior lip is pinched off and is followed by two prominent papillae. The jaws are hard and covered with a horny substance ; the posterior jaw is rounded and shovel-like. Between the anterior lip and the rostral fold there is a deep groove which becomes bifurcated near the base of the maxillary barbel ; the inner branch is continued round the corner of the mouth while the outer branch extends to the side of the head. There are 6 short stumpy barbels, 4 rostral and 2 maxillary, but in between the bases of the rostral barbels the rostral fold is produced into three barbel-like processes. At the side of the maxillary barbel, the rostral fold forms a lappet which is indented or crenulated. The gill-openings are small but extend to the ventral surface for a short distance ; the part of the gill-opening above the base of the pectoral fin is provided with a broad and thick gill-membrane.

The depth of the body is contained from 8·33 to 8·70 times in the standard length and from 9·87 to 10·15 times in the total length. The body is broadest in front of the pelvic fins where it is almost as broad as or somewhat broader than the width of the head. The caudal peduncle is strong and whip-like ; its least height is contained from 2·27 to 2·72 times in its length. The body is covered with small scales which are absent on the head and on the ventral surface as far as the anal opening. There are about 75-77 scales along the lateral line, 9 rows above it to the base of the dorsal fin and 9 rows of somewhat smaller scales below it to the base of the pelvic fin. There are about 20 predor-

sal scales. The dorsal and lateral scales in the anterior region are slightly keeled in the middle ; the keels become less prominent posteriorly. The anal opening is situated in a shallow groove which runs in the midventral line between the bases of the pelvic and anal fins.

The dorsal fin is short and commences almost opposite or slightly behind the pelvics ; it is considerably higher than the depth of the body. The commencement of the dorsal fin is considerably nearer to the tip of the snout than to the base of the caudal fin. The anal fin is similar to the dorsal and commences somewhat nearer to the base of the caudal fin than to that of the pelvic. The paired fins are broad, wing-like and horizontal ; the pectorals commence behind the eyes and are longer than the head ; they miss the bases of the pelvics by a short distance ; the pelvics are similar to the pectorals and are almost as long as the head ; they extend considerably beyond the anal-opening but are separated from the anal fin by a considerable distance. The caudal fin is almost as long as the head and is forked in the posterior third of its length ; both the lobes are rounded and the lower lobe is better developed and longer than the upper.

The form and structure of the basipterygium (Pl. VIII, fig. 8) and nature of the pharyngeal bone and teeth (Pl. VIII, fig. 9) are similar to those described above for *Bhavania australis*.

The body is dark above and pale below in the flattened part. Along the dorsal surface there is a series of 8-10 broad, saddle-shaped spots, while the head and the sides of the body are mottled with black spots of different sizes and pattern, some of which form a black band along the lateral line. All the fins are provided with series of spots, especially along the middle.

Type-specimen.—F. 13507/1, Zoological Survey of India (*Ind. Mus.*), Calcutta.

Locality.—Streams within a radius of 5 miles of Pampadampara, Peerumedu Taluq, Travancore.

I have great pleasure in associating the name of this remarkable new loach with that of Mr. S. Jones, who sent a fine collection of fish from Travancore to the Zoological Survey of India.

Measurements in millimetres.

Standard length .. .	59·1	62·9	70·0	75·0	87·0
Length of caudal .. .	10·6	11·1	12·0	14·0	14·5
Length of head .. .	11·2	12·2	12·0	15·0	16·0
Width of head .. .	9·4	9·6	11·0	13·0	12·0
Height of head .. .	6·8	6·6	7·0	8·0	8·5
Length of snout .. .	6·3	6·9	7·8	8·0	8·5
Diameter of eye .. .	2·2	2·6	2·9	3·0	3·5
Interorbital width .. .	3·6	3·9	4·2	4·5	5·0
Depth of body .. .	7·0	7·9	8·3	9·0	10·0
Width of body .. .	8·6	10·2	11·0	13·0	14·0
Length of caudal peduncle .. .	10·1	11·0	12·1	12·5	15·0
Least height of caudal peduncle .	3·8	4·1	4·6	5·5	5·5
Length of pectoral .. .	12·2	14·6	14·2	16·5	19·0
Length of ventral .. .	11·5	11·6	12·1	14·5	15·0
Longest ray of dorsal .. .	10·9	11·9	12·3	12·5	14·0
Longest ray of anal .. .	8·1	8·7	10·1	10·0	11·0

Balitora brucei var. **mysorensis,** nov.

Plate VIII, fig. 4.

D.3/9 ; A.2/5 ; P.9/12 ; V.2/9 ; C.19.

The new variety of *Balitora brucei* from the Mysore State is represented by a single specimen about 2 inches in length. In its slender body and more elongate head it shows great affinity to *B. brucei* var. *burmanicus* Hora[1], but as the material of the new variety is inadequate it is not possible to institute a detailed comparison between the two varieties. On geographical grounds alone, it has been considered advisable to keep the variety from Peninsular India separate from that of Burma, at least for the time being.

The head is contained 4·36 times in the standard length and 5·64 times in the total length. The width of the head is contained 1·41 times and its height at occiput 2·23 times in its length. The diameter of the eye is contained 5·56 times in the length of the head, 3·44 times in the length of the snout and 1·81 times in the interorbital width. The depth of the body is contained 7·61 times in the standard length and 9·84 times in the total length. The caudal peduncle is almost 3 times as long as high.

In general facies, lepidosis, form of fins, mouth, lips, etc. this variety agrees with the *forma typica* and other varieties of the species.

The colour in spirit is olivaceous above with a series of 7 short, broad, saddle-shaped bands of gray colour along the back. On the head between the eyes and the occiput there is a pear-shaped dark mark. Along the lateral line there is a diffuse gray band. The ventral surface is dirty white.

Locality.—Sivasamudram (alt. 1,500—2,000 ft.), Mysore State.

Type-specimen.—F. 13512/1, Zoological Survey of India (*Ind. Mus.*), Calcutta.

Measurements in millimetres.

Standard length	..	38·8
Length of caudal	..	11·4
Length of head	..	8·9
Width of head	..	6·3
Height of head	..	4·0
Length of snout	..	5·5
Diameter of eye	..	1·6
Interorbital width	..	2·9
Depth of body	..	5·1
Width of body	..	6·2
Length of caudal peduncle		6·2
Least height of caudal peduncle		2·1
Length of pectoral	..	10·2
Length of ventral	..	8·9
Longest ray of dorsal		8·0
Longest ray of anal	..	

, S. L., *Mem. Ind. Mus.* XII, p. 291, pl. xi, : (1932).

EXPLANATION OF PLATE VIII.

Homalopterid Fishes from Peninsular India.

Bhavania australis (Jerdon).

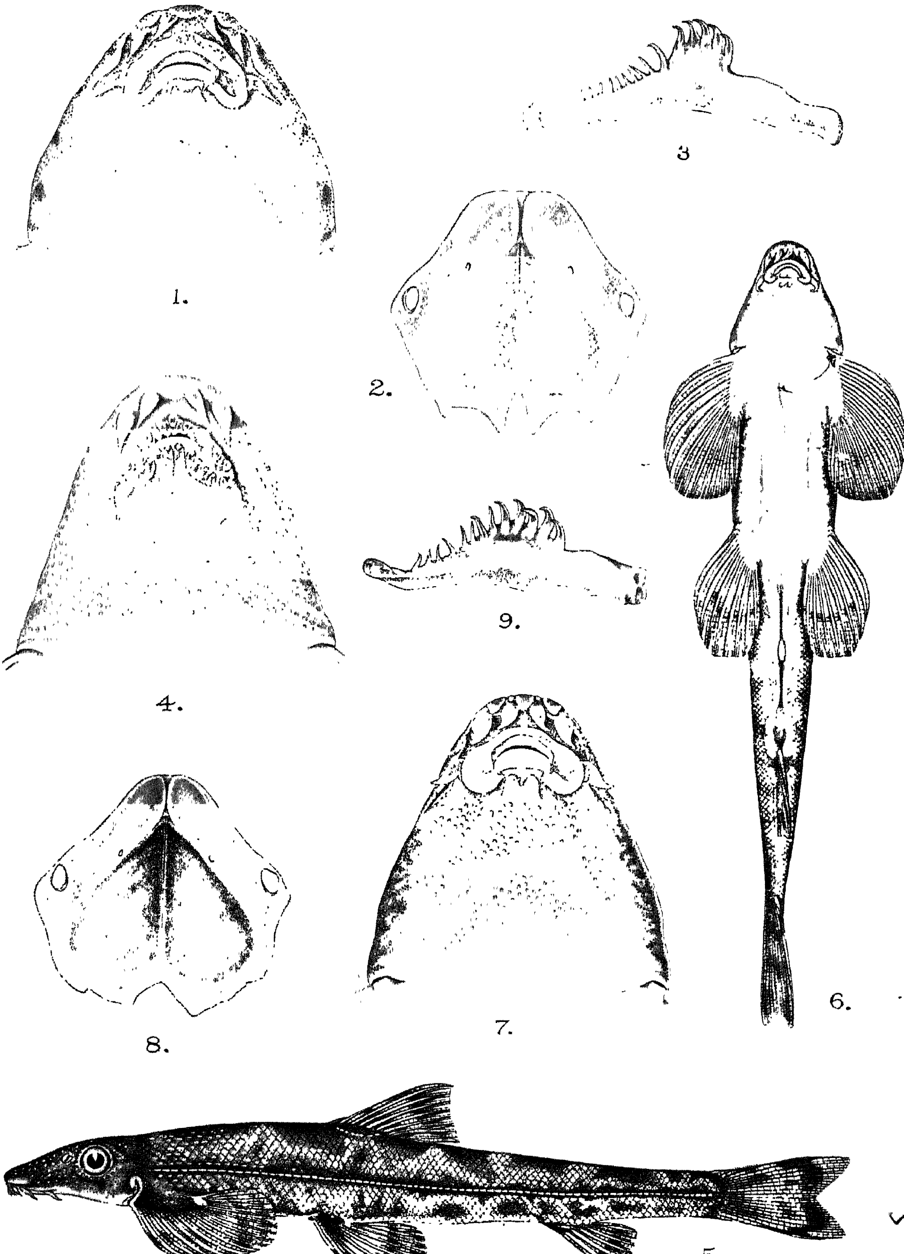
FIG. 1.—Ventral surface of head : $\times 4$.
FIG. 2.—Basipterygium : $\times 3\frac{3}{4}$.
FIG. 3.—Pharyngeal bone and teeth : $\times 13$.

Balitora brucei var. *mysorensis*, nov.

FIG. 4.—Ventral surface of head :

Travancoria jonesi, gen. *et* sp. nov.

FIG. 5.—Lateral view : $\times 1\frac{7}{8}$.
FIG. 6.—Ventral view : $\times 1\frac{7}{8}$.
FIG. 7.—Ventral surface of head : $\times$ *ca.* $4\frac{3}{4}$.
FIG. 8.—Basipterygium : $\times 3\frac{3}{4}$.
FIG. 9.—Pharyngeal bone and teeth : $\times 13$.



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B. N. Bagchi, del.

Homalopterid Fishes from Peninsular India.

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Siluroid Fishes of India, Burma and Ceylon. XI. Fishes of the Schilbeid genera *Silonopangasius* Hora, *Pseudeutropius* Bleeker, *Proeutropiichthys* Hora and *Ailia* Gray. XII. A Further Note on Fishes of the Genus *Clarias* Gronovius.

By

SUNDER LAL HORA

CALCUTTA:

JUNE, 1941

SILUROID FISHES OF INDIA, BURMA AND CEYLON

By SUNDER LAL HORA, *D.Sc.*, *F.R.S.E.*, *F.N.I.*, *Assistant Superintendent, Zoological Survey of India, Calcutta.*

XI. FISHES OF THE SCHILBEID GENERA *SILONOPANGASIUS* HORA, *PSEUDEUTROPIUS* BLEEKER, *PROEUTROPIICHTHYS* HORA, AND *AILIA* GRAY.

As the family Schilbeidae is represented by several genera in the Ethiopian and Oriental zoogeographical regions, it was my[1] intention to give a comprehensive account of the classification, distribution, ecology and evolution of these fishes, but considerable difficulty was experienced in carrying out this plan, partly owing to the great confusion that prevailed in the taxonomy of the Indian genera and species of this family, and partly because of the absence of African material in the collection of the Indian Museum for comparison with the Indian forms. Accordingly, the Indian genera have now been revised one by one and the generic limits of *Eutropiichthys* Bleeker[2] [*E. goongwaree* (Sykes), *E. vacha* (Hamilton) and *E. murius* (Hamilton)], *Clupisoma* Swainson[3] [*C. garua* (Hamilton), *C. prateri* Hora and *C. montana* Hora], *Silonia* Swainson[4] [*S. silondia* (Hamilton)], *Pangasius* Cuvier and Valenciennes[5] [*Pangasius pangasius* (Ham.)]; *Helicophagus* Bleeker[6] and *Platytropius* Hora[7] have already been elucidated. The taxonomy of the Indian species included in these genera has also been dealt with. This article deals with a systematic account of the remaining Indian genera of the Schilbeidae.

Key to the Indian genera of Schilbeidae.

I. Two barbels (maxillary); teeth caniniform; air-bladder[8] greatly reduced	*Silonia* Swainson.
II. Four or eight barbels.	
A. Four barbels; one pair maxillary, one pair mandibular.	
1. Caniniform teeth in jaws; air-bladder greatly reduced, without any caecum at the posterior end	*Silonopangasius* Hora.
2. Small, villiform teeth in jaws; air-bladder[9] large or of moderate size, usually with a caecum at the posterior end	*Pangasius* Cuv. & Val.

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1 Hora, S. L., *Cur. Sci.* V, pp. 352, 353 (1937).
2 Hora, S. L., *Journ. Bombay Nat. Hist. Soc.* XXXIX, pp. 431-446 (1937).
3 Hora, S. L., *ibid.* XXXIX, pp. 659-678 (1937).
4 Hora, S. L., *ibid.* XL, pp. 137-147 (1938).
5 Hora, S. L., *ibid.* XL, pp. 355-366 (1938).
6 Hora, S. L., *Rec. Ind. Mus.* XXXIX, pp. 235-240 (1937).
7 Hora, S. L., *Journ. Siam. Soc. Nat. Hist.* Suppl. XI, pp. 39-46 (1937).
8 Nair, K. K., *Rec. Ind. Mus.* XL, pp. 5-11 (1938.)
9 Nair, K. K., *ibid.* XXXIX, pp. 117-124 (1937)

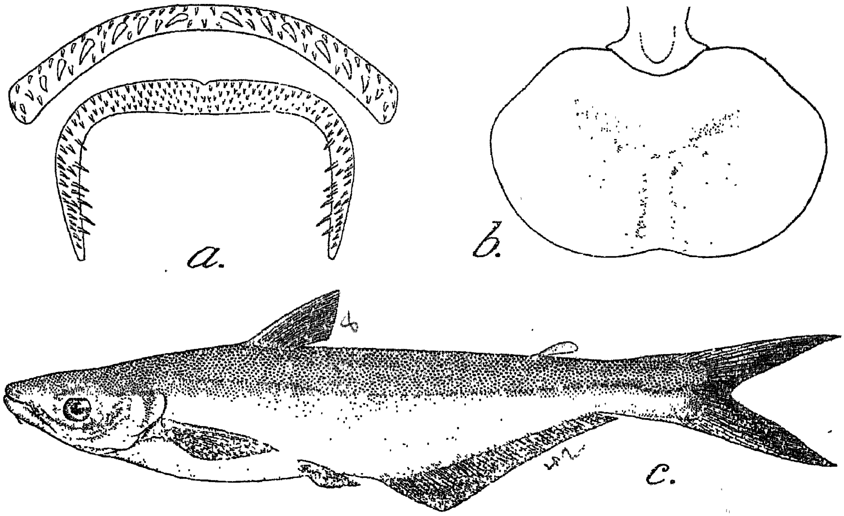
B. Eight barbels; one pair maxillary, two pairs mandibular, one pair nasal.

1. Teeth on palate in two small widely separated patches, sometimes connected by a linear series.
   - *a.* Rayed dorsal present; air-bladder large, forming blister-like areas above pectorals.
   - *b.* Rayed dorsal present; air-bladder[1] greatly reduced, tubular, partly covered by bone .. .. .. *Ailia* Gray.
2. Teeth on palate in four distinct contiguous patches or in a broad band sometimes interrupted in the middle.
   - *a.* Teeth on palate in four distinct patches; air-bladder of moderate size .. *Procutropiichthys* Hora.
   - *b.* Teeth on palate in two extensive patches separated in the middle or in a continuous horse-shoe-shaped band.
     - i. Maxillary and palatine teeth greatly produced backwards at the sides; air-bladder[2] greatly reduced, tubular .. .. *Eutropiichthys* Blkr.
     - ii. Maxillary and palatine teeth not produced backwards; air-bladder[3] greatly reduced, but not tubular .. .. .. *Clupisoma* Swainson.

Silonopangasius Hora.

1937. *Silonopangasius*, Hora, *Cur. Sci.* V, p. 352.

The genus *Silonopangasius* was proposed for *Ageneiosus childreni* Sykes.[4] This species, as I understand it, possesses caniniform teeth in the jaws and a pointed lower jaw, as in *Silonia*, and four barbels—one



Text-fig. 1.—*Silonopangasius childreni* (Sykes).
a. Dentition: × 3; *b.* Air-bladder: × 3: Lateral view of a specimen from the Bhavani River: × $\frac{2}{3}$.

[1] Nair, K. K., *Rec. Ind. Mus.* XL, pp. 185, 186 (1938).
[2] Nair, K. K., *ibid.* XL, pp. 183-185 (1938).
[3] Nair, K. K., *ibid.* XL, pp. 186, 187 (1938).
[4] Sykes, W. H., *Trans. Zool. Soc. London* II, p. 375 (1841).

pair maxillary and one pair mandibular—as in *Pangasius*. The air-bladder, though small and somewhat thick-walled, is considerably larger than that of *Silonia* ; it is oval in outline with the longer axis transversely disposed. On account of the structure of the air-bladder and the presence of a pair of mandibular barbels this species cannot be referred to *Silonia* or to *Pangasius* and has accordingly been placed in a separate genus.

Ageneiosus childreni was characterised by Sykes as follows :

"An *Ageneiosus*, without *cirri* ; with the first ray of the dorsal and pectoral fins serrated on the anterior edge only : with eight rays in the dorsal and 42 in the anal fin ; with two sharp lobes to the tail, the upper being somewhat the smallest."

Sykes mentioned the length of his specimen as 18 inches and remarked "flesh sweet and juicy, but not firm". As regards the affinities of his spicees he stated.

"A comparison of my drawing with the description of *Ageneiosus mino* of Dr. Hamilton's 'Fishes of the Ganges', will show how many features there are in common between it and the *Parree*; but its height and compressed body, and the extent of the anal fin, at once fix the latter as a distinct species. Found in the Mota Mola river, at Poona. *Pimelodus silorida* (*sic*) of Buchanan Hamilton (Tab. VII, fig. 50) is also an *Ageneiosus*."

The serrations along the anterior borders of the dorsal and the pectoral fins are obviously incorrectly shown in the figure of the species which most probably served for Sykes' description. Serrations are invariably present in Siluroid fishes along the inner borders of the spines, and the outer border may be smooth or serrated.

Jerdon,[1] who included this species in his list of fishes of Southern India, referred it to the genus *Silundia* and remarked :

"I have very little doubt that this is a true *Silundia*, and perhaps the *S. Gangetica* though Sykes says there are no cirri, for it appears that the two small cirri which are present in that fish are made out sometimes with difficulty."

Günther[2] included Sykes' species in the synonymy of *Silondia gangetica* without any comments ; while Day[3], when describing *Silundia sykesii*, made the following observations regarding this species :

"Sykes states that this fish is termed *Purree* Mahr. and *Sillun* in the Deccan, that it is *without cirri*, and also that the first bony ray is 'serrated' on the anterior edge", such being also shown in the figure. This last observation leads me to believe that he described from the drawing, which seems to have maxillary barbels indistinctly marked.

"The long maxillary barbels of this species [*S. sykesii*] at once serve to distinguish it from the *S. gangetica*, C. V."

The air-bladder of *S. sykesii* is described as "transverse, not enclosed in bone."

Day also referred to the presence of the mandibular barbels in *S. sykesii* and their absence in *S. gangetica* and came to the conclusion that no generic importance should be attached to this character. The generic distinction between the two species, however, rests mainly on the character of the air-bladder.

I have examined several examples of *Silonopangasius childreni* (Sykes). Three specimens (Nos. 1230, 1285, 8903) were purchased from Day and two out of these are labelled in Day's handwriting as *Silundia sykesii* ; these are 123 mm., 180 mm., and 200 mm. in standard length

[1] Jerdon, T. C., *Madras Journ. Litt. & Sci.* XV, p. 340 (1849).
[2] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 65 (1864).
[3] Day, F., *Journ. Linn. Soc. Zool.* XII, p. 569 (1876).

respectively. Recently 3 adult specimens were received from the Mota Mola river, the type-locality, and in 1918 the late Dr. N. Annandale had collected a large number of young specimens from the edge of the Godavari river at Rajahmundry in the Madras Presidency. So far as is known at present, the species is found in Deccan only.

As a result of the examination of the above noted material I am fully convinced that Day's *Silundia sykesii* is synonymous with Sykes's *Ageneiosus childreni*. The following table of measurements gives some idea of the range in variation of proportions, etc.

Measurements in millimetres.

	Bhavani R.		Godavari R.	Madras.		Deccan.		Poona.		
Total length	256·0	165·0	81·0	..	220·0	332·0	..	338·0	323·0	300·0
Standard length	199·0	133·0	61·5	197·0	179·0	271·5	123·5	271·5	255·0	235·0
Length of head	50·0	31·0	16·0	45·0	42·0	63·0	28·8	64·0	57·0	55·0
Width of head	31·0	18·0	11·0	25·0	23·0	40·0	15·0	35·3	31·0	29·0
Width of body	26·0	14·0	7·5	20·0	17·0	30·0	11·0	38·0	30·0	25·0
Height of body	49·0	30·0	13·5	40·0	37·0	57·0	21·5	62·0	57·0	55·0
Diameter of eye	13·2	9·5	5·5	13·0	12·5	17·0	9·0	17·0	16·0	14·8
Interorbital width	21·0	10·0	5·5	15·5	13·0	21·0	10·0	21·6	19·0	18·0
Length of snout	17·0	12·0	5·5	15·0	14·5	21·0	9·0	23·0	20·0	19·0
Length of maxillary barbel ..	12·0	11·0	12·0	16·0	15·5	28·0	15·5	31·0	26·0	25·0
Length of mandibular barbel ..	1·0	1·2	5·5	4·0	5·0	6·0	5·0	9·0	7·0	6·5
Length of dorsal spine ..	32·0	20·0	9·0	D.	D.	38·0	19·0	38·0	D.	D.
Length of pectoral spine ..	36·0	22·0	11·0	35·0	33·0	49·0	21·0	52·0	48·0	45·0
Least height of caudal peduncle.	18·0	11·0	5·0	16·0	15·5	20·0	10·5	25·0	20·0	20·0

Pseudeutropius Bleeker.

The genus *Pseudeutropius* was proposed by Bleeker[1] in the Pangasii to accommodate *Eutropius brachypopterus* Blkr. and was characterised as follows:

"Cirri 8, nasales 2, supramaxillares 2, inframaxillares 4. Dentes maxillis pluriseriati. Dentes vomerini in vittam transversam dispositi, palatini distincti nulli. Cirri inframaxillares omnes margini maxillae anteriori valde approximati. B. 10."

A year later Bleeker[2] revised this definition and stated "Dentes vomero-palatini in vittam transversam indivisam dispositi."

The chief points of differences between *Eutropius* and *Pseudeutropius* are: (i) The mandibular barbels are situated at a considerable distance from the anterior margin of the lower jaw in *Eutropius* and close to the margin in *Pseudeutropius*. (ii) In *Eutropius* the mandibular barbels are placed one pair behind the other, whereas in *Pseudeutropius* both the pairs are in a more or less straight line. (iii) The vomerine and palatine patches of teeth are distinct, though contiguous, in *Eutropius*; while in *Pseudeutropius* the vomero-palatine patches are transversely disposed and the vomerine teeth are indistinguishable from the palatine teeth.

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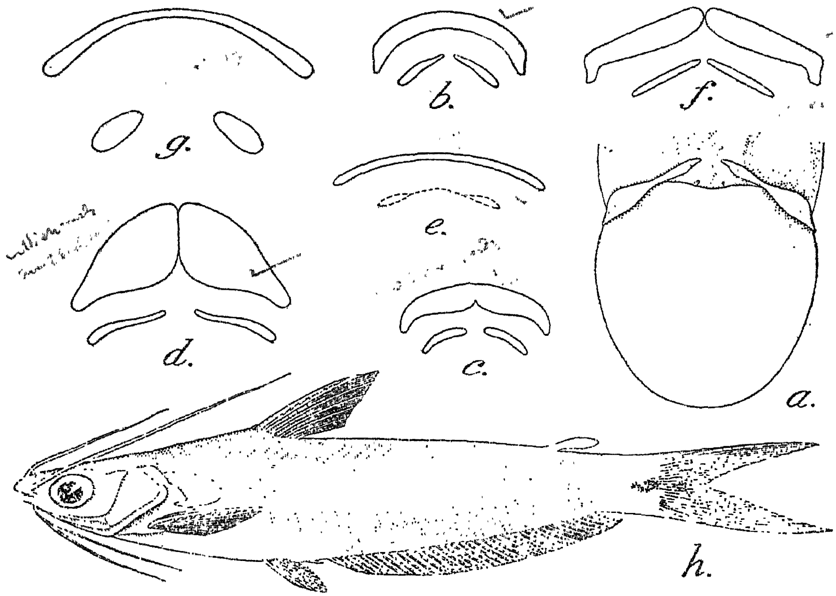
[1] Bleeker, P., *Versl. Akad. Amsterdam* XIV, p. 398 (1862).
[2] Bleeker, P., *Ned. Tijdschr. Dierk.* I, p. 106 (1863).

A study of the descriptions of the species included by Günther[1] and Day[2] under *Pseudeutropius* shows that they paid little attention to the limits proposed by Bleeker for this genus with regard to the dentition of its members. For instance, in the six species referred by Günther to this genus the vomerine teeth are stated to " form a very narrow band, which is angularly bent, and continuous with the palatine teeth " in *P. brachypopterus*, the type of the genus and of which Günther had a typical specimen from Bleeker's collection ; while the dentition of *P. atherinoides*, *P. mitchelli* and *P. goongwaree* is not described. In



Text-fig. 2.—*Pseudeutropius* Bleeker.

a. Air-bladder of *P. atherinoides* (Bloch), from a specimen 53 mm. in standard length : ×4$\frac{2}{3}$; *b.*, *c.* and *d.* Dentition of three specimens of *P. atherinoides* (Bloch), 57 mm., 74 mm. and 100 mm. in standard length respectively ; *b* : ×6 ; *c* : and *d* : ×4 ; *e.* Dentition of type-specimen of *P. brachypopterus* (Bleeker) after a sketch by Mr. J. R. Norman ; *f.* Dentition of *P. mitchelli* Günther after a sketch by Mr. J. R. Norman ; *g.* Dentition of a specimen (No. 430) of *P. mitchelli* Günther, 96 mm. in standard length ; *h.* Lateral view of a specimen (Cat. No. 502) of *P. atherinoides* (Bloch).

P. megalops, the teeth of the vomer form two quadrangular patches, which are separated from each other by a linear groove ; the palatine teeth form a cuneiform band which is subcontinuous with the vomerine teeth." In *P. longimanus*, " the vomerine band is interrupted in the middle, each half being subcontinuous with the palatine band." Taking into consideration the character of dentition it is clear that whereas there is considerable similarity between *P. megalops* and *P. longimanus*, both of these differ from *P. brachypopterus*, and should not be included under *Pseudeutropius* (*sensu stricto*).

[1] Günther, A., *Cat. Fish. Brit. Mus.* V, pp. 58-61 (1864).
[2] Day, F., *Fish. India*, pp. 470-474 (1877).

Day in his "Fishes of India" included seven species under *Pseudeutropius*; of all of these I have examined specimens determined by him. Though there are inaccuracies in his descriptions and figures of the dentition of the various species, I shall, for the point under discussion, refer to the account as given by him. In *P. goongwaree*, the teeth are "in a wide pyriform band wider than those in the jaws, the vomerine and palatine groups touching, but the two vomerine patches having a short interspace between them." In *P. taakree*, the vomerine and palatine teeth are in distinct patches. In *P. acutirostris*, the teeth are "in two minute patches on the vomer, and of the same character on the palatines, which are not continuous with those on the vomer." In *P. murius*, the teeth "on the vomer and palate form an almost uninterrupted semilunar band." The teeth on the palate of *P. sykesi* are "in two distinct patches." In *P. atherinoides*, there is "a narrow, uninterrupted, crescentic band across the palate," while in *P. garua* the teeth are "in a semilunar band across the palate, those of the vomer contiguous to those of the palatines, and each patch being semicircular internally: sometimes the two vomerine patches have an interspace between them." The great variation in the dentition of these species clearly shows that *Pseudeutropius*, as recongnised by Day, is a composite genus.

It is also clear from the above that dentition alone is not sufficient for the proper differentiation of the genus *Pseudeutropius*. I have, however, found that if this feature is coupled with the nature of air-bladder, it is possible to differentiate and define more precisely this and the allied Schilbeid genera occurring in India.

For determining the precise limits of the genus *Pseudeutropius*, I requested Mr. J. R. Norman to examine the type-specimen of *Pseudeutropius brachypopterus*, the type of the genus. He sent me a sketch of its dentition (Text-fig. 2*e*), and remarked that the specimen is in a poor condition and, in consequence, he had great difficulty in making out the outlines of the tooth-bands. According to Weber and de Beaufort[1] the dentition of *P. brachypopterus* consists of "Minute teeth in narrow bands on the jaws; on the vomer in two small patches connected by an angular line of teeth". Unfortunately no account has so far been published of the air-bladder in this species, but it seems probable that it is a large, thin-walled structure which laterally comes in contact with the skin and forms translucent, blister-like areas above the pectoral fins. Weber and de Beaufort (*op. cit.*) described another species of *Pseudeutropius*—*P. moolenburghae*—from Sumatra in which they found "Teeth minute, in the jaws in a narrow band, on the vomer in two widely separate elliptic patches." Its figure shows the translucent area above the pectoral fin, though there is no reference to the nature of the air-bladder in the description.

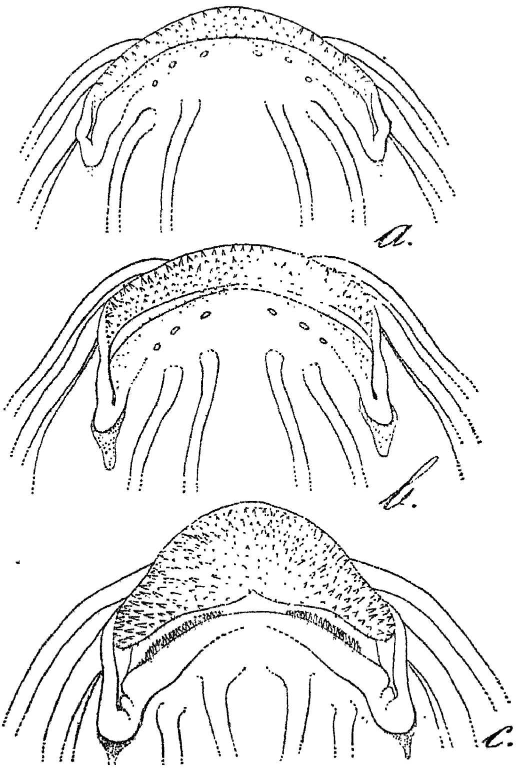
As judged from the material in the collection of the Indian Museum, it seems that *Pseudeutropius* is represented in the Indian waters by *P. atherinoides* (Bloch)[2] and *P. mitchelli* Günther[3]; both the species possess vomerine teeth in two distinct patches which may be small or

[1] Weber M. and Beaufort, L. F. de, *Fish. Indo-Austral. Archipel* II, p. 249 (1913).
[2] Bloch, M. E., *Naturges. Ausland. Fische* VIII, p. 48 (1794).
[3] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 59 (1864).

extensive but are always narrow, and a large air-bladder free in the abdominal cavity (Text-fig. 2*a*). As there appears to be a considerable confusion regarding the specific limits of the two species I give below their brief history and chief taxonomic features.

Pseudeutropius atherinoides (Bloch.)

P. atherinoides was described from Tranquebar, but later Hamilton[1] described two species from Bengal—*Pimelodus urua* and *P. angius*—which have rightly been regarded as synonymous with Bloch's species. Hamilton himself pointed out the close affinity between *P. urua* and *P. atherinoides*. *P. angius*, with brilliant colour markings, is only a colour form of *P. atherinoides*. Valenciennes's[2] *Bagrus exodon* is undoubtedly the same as Day's *Pseudeutropius acutirostris*.[3] The former was



Text-fig. 3.—Ventral surface of the anterior part of head of three specimens of *Pseudeutropius atherinoides* (Bloch), showing stages in the prolongation of the upper jaw and the development of teeth.

a. Standard length of specimen 59 mm.: $\times$ 10; *b*. Standard length of specimen 64 mm.: $\times$ 8; *c*. Standard length of specimen 100 mm.: $\times$ $5\frac{1}{3}$.

[1] Hamilton, F., *Fish. Ganges*, pp. 177, 180, 377 (1822).
[2] Valenciennes, A., in *Belanger Voyage Ind. Orient. Zool.*, p. 385 (1834).
[3] Day, F., *Proc. Zool. Soc. London*, p. 618 (1869).

described from Bengal whereas the latter is stated to be common in the Irrawaddy and other large Burmese rivers. The differences in dentition and colouration noticed among individuals of this species seem to indicate sexual dimorphism but the material is insufficient for a proper elucidation of this problem. In the collection of the Indian Museum there are specimens showing various stages in the elongation of the upper jaw and in one example from the Sunderbans typical *acutirostris*-condition of the snout is present. Though the figure of *Bagrus exodon* is rather poor for the determination of the species, the description of the dentition leaves no doubt about its identity. It runs as :

"Nous lui donnous cette épithéte d'*Exodon*, qui veut dire hors dents, parce qú elle caractérise notablement les dents inter-maxillaires adhérentes à de larges plaques au bout du museau, de manière à dépasser entièrement la mâchoire inférieure."

Chaudhuri[1] described a new variety of *P. atherinoides* from young specimens with the characteristic colour bands. "A narrow spiral corrugation on chest" in the variety *walkeri* is an artifact due to the action of the preservative used. The eyes are never subcutaneous in this species, and Chaudhuri's description is inaccurate on this point also.

Pseudeutropius mitchelli Günther.

Pseudeutropius mitchelli was described by Günther[2] from two young specimens, "Three and a half inches long", collected in the Madras Presidency. Unfortunately no specific locality is mentioned. In 1865, Day[3] regarded it as a synonym of *P. sykesi* (Jerdon) and remarked :

"By no means rare in the rivers of Malabar. In two specimens the adipose fin was absent, perhaps lost by some accident; probably from some such deformed specimen Dr. Jerdon described the *Schilbe sykesii*."

In his *Fishes of Malabar*, he reaffirmed this view and stated that the species grows to above eight inches in length. Günther in the *Zoological Record* for the same year (p. 199) made the following observation under *Pseudeutropius mitchelli* :

"Although Mr. Day states (*Fish. Malabar*, p. 192) that he has no doubt Mr. Jerdon described his *Schilbe sykesii* from an example without adipose fin, it must, even in that case, appear doubtful whether the fish is identical with *P. mitchelli*. If he cannot verify his assertion by the examination of the typical specimen, he has no right to exchange the name of a well-determined species for that of a doubtful one."

Day's reply to the above is contained in a footnote on p. 423 of his *Fishes of India* where after referring to Günther's observations he remarks : "Jerdon had described the species fifteen years before Dr. Günther, and sufficiently well for my recognizing it at a locality where he found it".

Jerdon's description[4] of *Schilbe sykesii* is of a generalised nature and insufficient for the determination of the species. Jerdon's examples,

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[1] Chaudhuri, B. L., *Rec. Ind. Mus.* VII, p. 444 (1912).
[2] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 59 (1864).
[3] Day, F., *Proc. Zool. Soc. London*, p. 289 (1865).
[4] Jerdon's description of *Schilbe sykesii* (*Madras Journ. Litt. Sci.* XV, p. 335, 1849) is as follows :

"Head one-fifth of whole length of body; much compressed, its width being about half its length; eye large, being $3\frac{1}{2}$ times in the head; maxillary cirri reach the ventral fin, all the other (6) cirri longer than the head; dorsal and pectoral spines serrated; the latter strongly so; anal fin about one-third of length of body—D. 1-6; A. 36—colour greenish above, silvery on the sides and beneath."

about 6 inches in length, were obtained from the Cauvery. Recently I have got a large collection of fish from the same river made by Prof. C. R. Narayan Rao. There is a specimen in this collection which I refer to Jerdon's species. A thorough examination of this specimen and its comparison with others have shown that it undoubtedly belongs to *P. sykesi* which has proved to be identical with Sykes' *Hypophthalmus taakree*[1]. Of the latter I have received a large number of fresh specimens from the Western Ghats, so there can be no doubt about its true identity.

The three specimens in the collection of the Indian Museum referred by Day to *P. sykesi* are about 5 inches in length without the caudal fin. The vomerine teeth in these specimens are in two distinct patches and the air-bladder is moderately extensive and lies free in the abdominal cavity; it also forms blister-like translucent areas above the pectoral fins. Mr. Norman very kindly examined the types of *P. mitchelli* and sent me a sketch of its upper dentition. He also observed that the "blister-like translucent area above the pectoral fin is indicated in the types of this species." The difference in the extent of the vomerine teeth of *P. mitchelli* and *P. sykesi* (Day *nec* Jerdon), as figured above, is probably due to the relative age of the specimens. I have noticed this in the case of *P. atherinoides* also; in the young the bands on the palate are more extensive and become somewhat reduced as the fish grows in size. From the above it is clear that Day was right in regarding *P. mitchelli* as identical with his *P. sykesi*, but unfortunately his *P. sykesi* is not the same as *P. sykesi* (Jerdon) which has now to be regarded as a synonym of *P. taakree* (Sykes). Thus *P. mitchelli* stands as a valid species.

Superficially *P. mitchelli* and *P. atherinoides* are very similar, but Mr. Norman informs me that the former has a smaller head, with the nape distinctly less elevated. These differences are also present in the specimens before me. In the adult specimens of *P. atherinoides* the snout is usually produced and bears teeth on the ventral surface.

Günther states that in his *P. mitchelli* the pectoral spine does not extend backwards to the vertical from the dorsal spine. This is not so in three specimens I refer to this species wherein the pectoral spine extends beyond the base of the dorsal spine.

Proeutropiichthys Hora.

1937. *Proeutropiichthys*, Hora, *Cur. Sci.* V, p. 353.

The genus *Proeuropiichthys* was proposed for such species of *Pseudeutropius*-like fishes in which the vomerine and palatine teeth form four distinct patches; these may be contiguous, slightly separated or widely apart from one another. The air-bladder is not extensive and thin-walled as in *Pseudeutropius*, but is of moderate size and lies free in the abdominal cavity.

Eutropius macrophthalmus Blyth was designated as the genotype of *Proeutropiichthys*, but an examination of fresh material from various

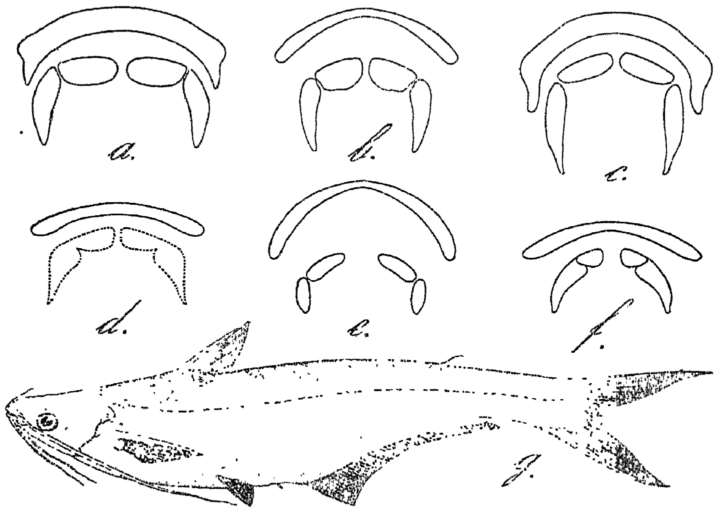
[1] Sykes, W. H., *Trans. Zool. Soc. London* II, p. 369 (1841).

localities in Peninsular India has shown that it is synonymous with *Hypophthalmus taakree* Sykes. As indicated below, this genus seems to be monotypic.

Proeutropiichthys taakree (Sykes).

1841. *Hypophthalmus taakree*, Sykes, *Trans. Zool. Soc. London* II, p. 369, pl. lxiv, fig. 4.
1849. *Schilbe Sykesii*, Jerdon, *Madras Journ. Litt. Sci.* XV, p. 335.
1849. *Bagrus taakree*, Jerdon, *ibid.*, p. 336.
1853. *Bagrus taakree*, Bleeker, *Verh. Bat. Gen.* XXV, p. 56.
1860. *Eutropius macrophthalmus*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 156.
1864. *Pseudeutropius megalops*, Günther, *Cat. Fish. Brit. Mus.* V, p. 60.
1864. *Pseudeutropius longimanus*, Günther, *ibid.*, p. 60.
1867. *Eutropius taakree*, Day, *Proc. Zool. Soc. London*, p. 564.
1869. *Pseudeutropius taakree*, Day, *ibid.*, p. 617.
1877. *Pseudeutropius taakree*, Day, *Fish. India*, p. 471, pl. cix, fig. 4.
1889. *Pseudeutropius taakree*, Day, *Faun. Brit. Ind.* Fish. I, p. 138.
1890. *Pseudeutropius taakree*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 205.
1929. *Pseudeutropius taakree*, Prashad and Mukerji, *Rec. Ind. Mus.* XXXI, p. 178.

In view of the great taxonomic confusion that prevails regarding the specific limits of the various species included in the synonymy of *P. taakree*, I give below a short history of each and my reasons for making the nomenclatorial changes indicated above.



Text-fig. 4.—*Proeutropiichthys taakree* (Sykes).

a. Upper dentition of a specimen from Burma, 126 mm. in total length : × $2\frac{3}{4}$; *b.* Upper dentition of a specimen from the Godaveri River, 136 mm. in total length : × $3\frac{1}{2}$; *c.* Upper dentition of a specimen without history, 119 mm. in standard length : × 3 ; *d.* Upper dentition of type-specimen of *Pseudeutropius longimanus* Günther. After a sketch by Mr. J. R. Norman ; *e.* Upper dentition of a specimen from Poona, 102 mm. in standard length : × $4\frac{1}{2}$; *f.* Upper dentition of type-specimen of *Pseudeutropius megalops* Günther. After a sketch by Mr. J. R. Norman ; *g.* Lateral view of a specimen (No. F. 12131/1) from Poona : × $\frac{3}{8}$.

Sykes described his *Hypophthalmus taakree* from specimens collected in the " Beema river, near Pairgaon ", and characterised it as follows :

" An *Hypophthalmus*, with 8 cirri, 2 of which reach to the ventral fins ; 2 very minute *cirri* near the nostrils, and 4 on the chin, nearly as long as the head ; with the first dorsal and pectoral rays serrated on the posterior edges, and with 8 rays in the dorsal and 50 in the anal fin."

From a perusal of the full description and figure of the species attention may be directed to the following other salient features of the fish :

(i) " Eyes so much on the edge or side of the head as to be seen in half their diameter from below."

(ii) " Tail being bent downwards from the end of the second dorsal and anal fins."[1]

(iii) " Snout nearly on a line with the level of the back, which is very slightly raised : belly more arched than the back ".

Though as judged by modern standards, this species is insufficiently characterised, it is so common in the Deccan that there can be no doubt about its identity. I have examined large series of specimens of this species from Poona, Deolali, Hyderabad-Deccan, Godaveri, etc. There are, no doubt, marked variations in the number of rays in the anal fin and also in the development of dentition, but these are hardly of any specific value, especially when they intergrade. Being a variable species, it seems to have been described by later workers under several names.

Jerdon included this species in his list of the freshwater fishes of Southern India but gave a wrong diagnosis of the fish mentioning " Adipose fin long, anal fin short." In fact, the reverse of this was described by Sykes. *Schilbe sykesii* of Jerdon also appears to be synonymous with *P. taakree* as indicated above under *Pseudeutropius mitchelli* Günther (*vide supra*, p. 105).

Bleeker also recognised *P. taakree* as a valid species, but both Jerdon and Bleeker included it under *Bagrus*.

Blyth described *Eutropius macrophthalmus* from Tenasserim and characterised it as follows :

" Of the usual form of this genus, but with remarkably large eyes, that occupy more than half of the height of the head. Longer maxillary cirri reaching to the vent, the four inferior cirri to base of pectorals ; spines slender, the pectoral less so, and all minutely pectinated behind ; the dorsal also jagged in front for its basal half."

" D. 1-7.-A. 47 to 54."

" Colour bright silvery infuscated along the back, with a golden lustre on the gill covers. Soft rays of the dorsal and pectoral infuscated except at base ; also the median portion of the deeply forked caudal, while several outer rays of the caudal above and below are white throughout. Ventrals and anal white ; the slender adipose fin having minute dusky spots. Longest specimen 6½ in."

Günther[2] regarded this species as a doubtful form of *Pseudeutropius*, while Day[3] considered it as a synonym of *P. goongwaree*[4]. I[5] have already shown the precise specific limits of Sykes' *goongwaree* and its position in the genus *Eutropiichthys*. Though Blyth's description of

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[1] This is an artifact. I have examined a specimen from Poona in which the back is arched as described by Sykes ; it is figured here as text-fig. 4*g*.

[2] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 58 (1864).

[3] Day, F., *Fish. India*, p. 471 (1877).

[4] Sykes, W. H., *Trans. Zool. Soc. London* II, p. 369 (1841).

[5] Hora, S. L., *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 435 (1937).

the species, especially on account of the absence of any reference to dentition of the fish, is insufficient for its precise determination I am convinced that this 'large-eyed *Eutropius*' could not be anything else except the form described by Day as *P. taakree* from Burma. Under *P. taakree* Day observed: "I have obtained in Burmah, as high as Mandalay, specimens which I am unable to separate from this species, except that in some the pectoral spine is slightly shorter, in other the adipose fin is almost or quite absent". I have examined specimens from Pegu and Mandalay referred by Day to *P. taakree* and also fresh specimens collected by Dr. B. N. Chopra in the Myitkyina District, Upper Burma. The latter specimens were reported upon by Prashad and Mukerji who remarked:

> "The samples before us from Kamaing differ from Day's description mainly in their head being broader, the maxillary barbels shorter; the dorsal as well as the pectoral spines besides being denticulated posteriorly, are finely serrated anterirorly. Day 'obtained in Burma, as high as Mandalay', specimens apparently belonging to this species but with a shorter pectoral spine. It is quite possible that the Burmese specimens of *P. taakree* are distinct from the Indian."

The differences noted above are probably due to the large size of the Burmese examples in the collection studied by Prashad and Mukerji, for in larger specimens from Deccan the pectoral and dorsal spines are granulated along the anterior border. In smaller individuals these serations are very fine and the outer border of the spine may appear as smooth. It is quite possible, however, that the Burmese race of the species may prove to be distinct but at the present the material from Burma is not sufficient to make such a detailed study.

Though Günther[1] doubtfully referred *Hypophthalmus taakree* Sykes to *Eutropius*, he described two species under *Pseudeutropius*, *P. megalops* and *P. longimanus*, which appear to be synonymous with Sykes' *P. megalops* was described from a single specimen "Six inches Godaveri at Mahadespur, Orissa. From the Collection of Messrs. V. Schlagintweit." Day[2] included this species, with a query, under the synonymy of *P. murius*, and no other author appears to have commented on the specific limits of this species. In order to verify Day's contention I sent a sketch of the dentition of '*P. murius*' (I[3] have included *murius* in the genus *Eutropiichthys*.) to Mr. J. R. Norman of the British Museum and requested him to compare it with the dentition of the type-specimen of *P. megalops*. He informed me that "The type of this species [*P. megalops*] has a dentition quite different to that shown in your sketch, so that I have given a rough sketch of this (Text-fig. 4 *f*). A second specimen in the British Museum identified as *P.* (120 mm.) has a dentition agreeing exactly with your sketch." On further enquiry I learnt that the second specimen of *P. megalops* came from North East Bengal and formed part of the collection made by Jerdon.

The above information definitely clears up two points: (i) that *P. megalops* and '*P. murius*' are two distinct species and (ii) that Day may have been misled in his conclusion on account of the wrong identification of Jerdon's specimen in the British Museum.

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[1] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 52 (1864).
[2] Day, F., *Fish. India*, p. 472 (1877).
[3] Hora, S. L., *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 435 (1937).

To bring out the differences between *P. megalops* and " *P. murius* " I requested Mr. Norman to compare the two specimens of *P. megalops* in the British Museum. He very kindly sent me the following note on this point.

" With regard to the two specimens of *Pseudeutropius megalops* of which the dentition is different these are certainly not of the same species and there is little doubt that Jerdon's specimen has been incorrectly named. In the type of *P. megalops* the depth of the body is 5¼ in the length without the caudal fin and the head 5, whereas in Jerdon's specimen the depth is 4 and the head 4¾. Further the maxillary barbel extends beyond the origin of the anal fin in the type and the caudal peduncle is longer than deep, whereas in Jerdon's specimen the barbel only reaches the first quarter of the pectoral spine and the caudal peduncle is about as deep as long. There are other minor differences but these are the more important."

In the collection of the Zoological Survey of India, there are 4 specimens from the Godaveri River collected by Dr. N. Annandale at Rajahmundry which agree fairly closely with Günther's description of *P. megalops*, especially in the form of the dentition (Text-fig. 4 *b*). The proportions, length of barbels, etc. differ to a certain extent, but these differences cannot be regarded as specific. The number of anal rays varies from 42 to 49. I give below a table of measurements of these examples, which seem to me to belong to *P. taakree.*

Measurements in millimetres.

Standard length	108·5	103·0	65·0	55·0
Length of head	24·0	21·5	14·5	11·8
Width of head	13·5	12·0	7·8	6·0
Height of head at occiput	15·5	14·5	10·0	8·5
Length of mouth	5·0	4·0	3·0	2·5
Width of mouth	6·4	5·5	4·1	3·3
Diameter of eye	7·0	7·0	6·0	5·1
Length of snout	8·0	8·0	4·9	4·0
Interorbital width	7·5	7·2	4·5	4·0
Width of body	11·0	11·0	7·0	5·0
Height of body	20·0	18·0	12·5	9·0
Length of pectoral spine	20·4	19·0	11·0	D.
Length of dorsal spine	17·5	16·0	8·8	7·0
Length of nasal barbel[1]	10·5	10·0	7·0	4·5
Length of maxillary barbel[2]	50·0	46·5	29·0	25·2
Length of outer mandibular barbel	25·0	24·0	12·0	10·0
Length of inner mandibular barbel	25·5	25·4	13·0	12·0
Length of caudal peduncle	16·0	14·0	7·5	6·5
Least height of caudal peduncle	9·0	8·5	5·0	4·0
Commencement of dorsal from tip of snout	34·0	31·5	20·5	16·5

P. longimanus was described from a " Skin : 6 inches long : not good state. India. From the Collection of the Zoological Society." The main difference from *P. megalops* seems to consist in the number of rays in the dorsal and anal fins (D. 1/6 ; A. 41 for *P. megalops* and D. 1/8 ; A. *ca* 54 for *P. longimanus*). I have referred above to the variation in the number of anal rays of *P. taakree* and after having examined large series of specimens it is not possible for me to recognise

[1] Reaching to the middle of the eye-diameter.

[2] The length of maxillary barbels is very variable ; usually they extend to the end of the pelvic fins but they may be shorter or longer.

the above differences as of any specific value. Accordingly, I agree with Day[1] that *P. longimanus* is synonymous with *P. taakree.* Day[2] was of the opinion that the type-specimen of *P. longimanus* was from the collection of Col. Sykes and may have been the original of his *P. taakree.*

At my request, Mr. J. R. Norman sent to me a sketch of the dentition of *P. longimanus* (Text-fig. 4 *d*) and it also shows that the species is identical with *P. taakree.* There are two old, poorly preserved specimens in the Indian Museum (Cat. No. 509) without any locality label or name of donor in which the number of fin-rays and dentition (Text-fig. 4 *c*) correspond with Günther's description of *P. longimanus.*

As noted in the case of several other Indian species, the distribution of *P. taakree* is also of zoogeographical interest ; it is found in Deccan on the one hand and Burma on the other, and has not yet been recorded from the intermediate regions. There is one lot of 6 old specimens in the collection of the Indian Museum (No. Cat. 507) which is labelled to have been collected at Calcutta. This record seems to be rather doubtful.

Ailia Gray.

The generic name *Ailia* was proposed by Gray as a subgenus of *Malapterus* (*sic*) to accommodate his species '*Malapterus* (*Ailia*) *Bengalensis*' figured in the *Illustrations of Indian Zoology.* This figure is a copy of Hamilton's original drawing of *Malapterurus coila.* The definition of the genus is, however, given in the *Zoological Miscellany* (p. 8, 1831) and is as follows :

" Body compressed ; fins all spineless ; fat fin very short and small over the end of the very long anal fin ; ventral fins all nearly under the pectoral ; tail forked. Most allied to *Melapterus* of Geoffroy."

At the same time Gray described the genus *Acanthonotus* for *A. hardwickii* which is also figured in the *Illustrations.* Both the figure and the description appear to be based on a badly preserved specimen of *Ailia coila* (Ham.) in which the neural spines projected beyond the dorsal profile giving the false appearance of " a series of small spines " before the spineless dorsal. Though the latter generic name has line priority over *Ailia*, it is not accepted here owing to its diagnosis being very defective.

The genus *Ailia* is remarkable in several respects and Bleeker[3] constituted a separate group Ailianini in the sub-family Ailichthyoidei for its reception. Günther[4], however, included it in his composite group Silurina, but Regan[5] in his classification of the Siluroid fishes accommodated it in a separate subfamily—Ailiinae—of the Schilbeidae. The most salient features of *Ailia* are : (i) tubular, horse-shoe-shaped air-bladder, (ii) absence of rayed dorsal ; (iii) presence of a small adipose dorsal, (iv) long anal fin ; (v) eight well-developed barbels ; (vi) forked caudal and (vii) fairly well marked dentition. Of these, great import-

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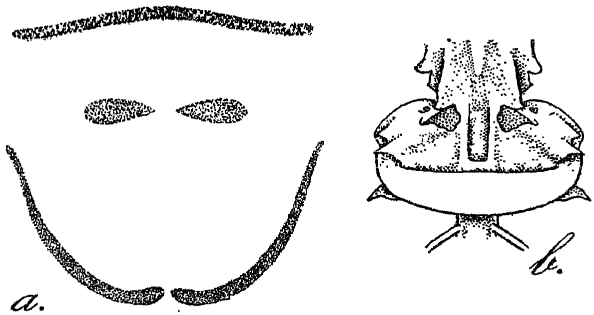
[1] Day, F., *Proc. Zool. Soc. London*, p. 617 (1869).
[2] Day, F., *Fish. India*, pp. iv (under Sykes), 471 (1877).
[3] Bleeker, P., *Ichth. Arch. Ind. Prodr.* I, Siluri, pp. ix, 248 (1858).
[4] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 55 (1864).
[5] Regan, C. T., *Ann. Mag. Nat. Hist.* (8) VIII, p. 567 (1911).

ance has been attached to the structure of the air-bladder which has been described by Day[1], Bridge and Haddon[2] and Nair[3].



Text-fig. 5.—Dentition and air-bladder of *Ailia coila* (Hamilton). *a.* Dentition: × 8; *b.* Air-bladder: × 5.

In 1871, Day (*loc. cit.*) established the genus *Ailiichthys* for *A. punctata* found in "The Jumna, and southern rivers in the Punjab that are tributaries of the Indus, but not those on the hills," and characterised it as: "Differing from *Ailia* in that the ventral fins are entirely absent." In several cases I have previously referred to the absence of pelvic fins in fishes and shown that no reliance can be placed on this character for taxonomic purposes. In *Ailia*, for instance, the body is greatly compressed and almost leaf-like. The pelvic fins are very small and lie below the pectorals. In these circumstances their function is taken over by the pectorals, which are somewhat more elongated than usual, and in consequence the pelvics may be regarded as mere vestigeal organs. It is no wonder, therefore, if under certain circumstances they do not make their appearance altogether. Similar cases of abnormality have been observed by a number of workers. Günther[4] explained the absence of pelvics on the assumption that "The chief function of these fins is to balance the body of the fish whilst swimming; and it is evident that, in fishes moving during a great part of their life over swampy ground, or through more or less consistent mud, this function of the ventral fins ceases, and that nature can readily dispense with these organs altogether." This is probably true in the case of such genera as *Channallabes*, *Apua*, *Channa*, etc. which live in mud or vegetable débris, but *Ailia* is certainly not a bottom fish as is evident from its form and colouration. In the case of *Ailia* it seems probable that owing to the extension of the tail region and the compression of the head and body there remains very little space for the attachment of the pelvic fins. Moreover, the elongation of the pectorals as far back as the anal fin rendered the presence of pelvics as useless. In the economy of nature,

[1] Day, F., *Proc. Zool. Soc. London*, p. 712 (1871).
[2] Bridge, T. W. and Haddon, A. C., *Phil. Trans. Roy. Soc. London* (B) CLXXXIX, p. 208 (1894).
[3] Nair, K. K., *Rec. Ind. Mus.* XL, pp. 185, 186 (1938).
[4] Günther, A., *Ann. Mag. Nat. Hist.* (4) XII, p. 143 (1873).

therefore, these organs may sometime be totally absent. In view of what is stated above, I do not consider *Ailiichthys* as a separate genus from *Ailia*. In fact, my examination of the material in the collection of the Indian Museum shows that *Ailiichthys punctatus* Day is synonymous with *Ailia coila* (Ham.). Thus I am able to recognise only one species in this geneus.

XII. A FURTHER NOTE ON FISHES OF THE *Clarias*

In 1936, I[1] discussed the systematic position of the various forms of *Clarias* described from India, Burma and Ceylon, and concluded that only three species can be recognised from these regions, *viz.*, *C. batrachus* (Linn.) (Ceylon, India, Burma, the Malay Archipelago and further east), *C. brachysoma* Günther (Ceylon) and *C. dayi* Hora (Wynaad Hills). Since then I have examined the Siluroid material preserved in the collections of the Bombay Natural History Society and the Government Museum, Madras, and among them found specimens (2 from Karkala, South Canara District and 7 from Goa), which, though closely allied to *C. brachysoma*, differ in certain respects from all the three species enumerated above. A similar specimen was also found in a collection of fishes sent by Prof. P. W. Gideon for determination ; it was collected in a *nullah* near Belgaum. A close study of these specimens and literature has shown that they are referable to *C. dussumieri* Cuv. & Val.,[2] which was described from Malabar and Pondicherry from specimens 7 to 8 inches in length, and distinguished from *C. batrachus* (=*C. magur*) by the following characters :—

> " avec la tête lisse et large de la deuxième [*C. magur*], a les épines pectorales plus sensiblement dentées, et les dents de l'arc vomérien approachent plus de la forme de petits pavés que de celle de dents en velours ras."

Though *C. dussumieri* was found by Jerdon[3] " in tanks and ditches in Malabar ", Günther[4] regarded it only as a *species inquirendum*. At the time of writing ' The Fishes of Malabar ', Day[5] had not examined any specimen of the species but later he[6] found one example, 7 inches long, from the Wynaad which he assigned to *C. dussumieri*. This specimen, which is now preserved in the collection of the Indian Museum and is in a very poor state of preservation, was found by me (*loc. cit.*) to be abundantly distinct from all the known species of the genus and was accordingly made the type of a new species *C. dayi* Hora. In my previous note I regarded *C. dussumieri* as a synonym of the widely distributed Indian species, *C. batrachus*, but fresh material from the Malabar zone has convinced me that it is worthy of recognition as a distinct species. It is distinguished from *C. batrachus*, among other characters, by its greater distance between the occipital process and

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[1] Hora, S. L., *Rec. Ind. Mus.* XXXVIII, pp. 347-351, text-figs. 1-5 (1936).
[2] Cuvier, G., and Valenciennes, A., *Hist. Nat. Poiss.* XV, p. 582 (1840).
[3] Jerdon, T. C., *Madras Journ. Litt. & Sci.* XVI, p. 342 (1849).
[4] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 17 (1864).
[5] Day, F., *Fishes of Malabar*, p. 197 (1865).
[6] Day, F., *Fish. India*, p. 484 (1877).

commencement of the dorsal fin; from *C. brachysoma* in having a more coarsely serrated pectoral spine, somewhat shorter barbels and more obtuse teeth on the palate and from *C. dayi* in having much longer nasal brabels, less molariform teeth and less strongly serrated pectoral spine. It is thus in several respects an intermediate form between *C. brachysoma* and *C. dayi*.

Specimens of *C. brachysoma* from Ceylon have usually been referred to *C. teysmanni* Bleeker (Java, Sumatra, Borneo and Malacca), but after an examination of the type material of both the species in the collection of the British Museum of Natural History, Mr. J. R. Norman (*vide* Hora, *loc. cit.*, p. 349) showed that the two forms are distinct. Generally speaking, there is no doubt regarding the very close similarity between the species typical of the Malabar zone and Ceylon on the one hand and of the Malay Archipelago on the other. Attention may here be directed to an error in my previous article on *Clarias* in the explanation of text-figure 2, *viz.*, text-figure 2*a* represents, after Norman, the vomerine tooth band of *C. brachysoma* and text-figure 2*b* that of *C. teysmanni* and not *vice versä* as was then described.

For facility of reference in future I give below full descriptions of *C. dussumieri* Cuv. & Val. For a detailed account of *C. dayi* Hora reference may be made to Day's descriptions of *C. dussumieri* both in the *Fishes of India* and in the *Fauna*.

Clarias dussumieri Cuvier and Valenciennes.

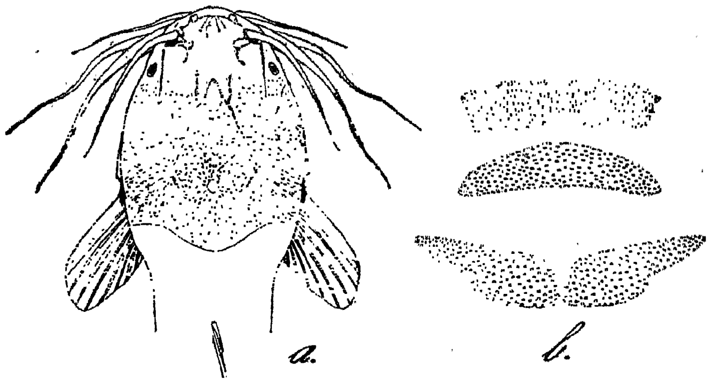
1840. *Clarias Dussumieri*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* XV, p. 382.

D. 66-69 ; A. 45-59 ; P. 1/10-11 ; V. 6.

Clarias dussumieri is an elongated fish in which the depth of the body is contained from 8·4 to 9·4 times, the length of head to end of gill-cover 6 times and to end of occipital process 4·5 times in the total length. The height of head is contained from 1·5 to 1·7 times in its length. The head is almost as broad as long. The diameter of the eye is contained from 8 to 10 times, the length of snout from 2·7 to 3·2 times and the interorbital width 1·8 times in the length of the head. The occipital process is broadly rounded ; its height is considerably less than half the length of its base. The distance between the origin of dorsal and occipital process is contained about 3 times in the length of the head to the end of the occipital process.

The dorsal surface of the head is roughened with ridges. The frontal fontanel is almost twice as long as broad and extends as far as the front border of the eye, while the occipital fontanel is oval and much shorter. The interorbital distance is greater than the width of the mouth and is almost equal to the postorbital part of the head. The nasal barbels extend as far as the occipital fontanel ; the maxillary barbels extend beyond the bases of the pectorals ; the outer mandibulars reach the bases of the pectorals while the inner mandibulars are shorter. There are villiform teeth in the jaws ; those in the upper jaw are in the

form of a continuous band one-fifth as broad as long; those in the lower jaw are grouped in two contiguous patches which are produced back-



Text-fig. 6.—*Clarias dussumieri* Cuvier and Valenciennes.

a. Dorsal surface of head and anterior part of body up to commencement of dorsal fin: × $\frac{4}{5}$; *b*. Dentition: × $2\frac{1}{2}$.

wards at the sides. The vomerine teeth are conspicuously obtuse and are situated in a broad crescentic band.

The dorsal fin commences almost above the termination of the pectorals and is separated from the caudal by a distinct notch. The caudal fin is longer than the head and is roundly pointed at the end; it is not confluent with the anal and the dorsal fins. The pectoral fin is considerably shorter than the head; its spine is strong and conspicuously serrated along the outer border; along the inner border it is provided with a few small teeth in the middle. The pelvic fins extend beyond the commencement of the anal fin.

In the preserved specimens there are no distinct markings; the general colour is somewhat darker above and lighter below.

Variations.—The above description is based on two fine examples from Karkala in South Canara District. The seven specimens from Goa are in a poor state of preservation but generally agree in almost all particulars with the Karkala examples. The specimen from Belgaum is, however, stumpy and stout with the body considerably deeper, head somewhat broader and the paired fins shorter. The pectoral spine is relatively much shorter.

Distribution.—Along the Malabar Coast generally; it has been recorded from Pondicherry, Goa, South Canara and Belgaum.

Remarks.—Except for the differences in the nature of the pectoral spine and vomerine teeth, and the length of barbels *C. dussumieri* is closely related to *C. brachysoma* of Ceylon and *C. dayi* of the Wynaad. In the following Table I give measurements of 3 specimens of *C. dussumieri* and of 3 specimens of *C. brachysoma* for purposes of comparison.

Measurements in millimeters.

	C. dussumieri			*C. brachysoma*		
	Karkala.		Belgaum.	Ceylon.		
Total length	253·0	227·0	178·8[1]	252·2[2]	236·0	206·0
Length of caudal	34·0	33·0	22·5	33·0	34·0	28·2
Depth of body	30·0	24·0	26·0	35·0	29·2	30·5
Length of head to end of opercle	41·2	38·0	34·2	44·0	40·0	33·0
Length of head to end of occipital process	54·3	49·6	43·4	54·2	50·5	44·5
Height of head	27·8	22·0	22·3	29·8	25·2	25·0
Width of head	38·0	34·5	33·0	39·5	37·5	31·8
Length of snout	14·3	13·8	10·5	15·2	14·0	10·5
Diameter of eye	5·0	3·9	3·0	4·2	4·2	3·5
Interorbital width	22·6	21·0	19·0	24·0	23·2	19·0
Length of pectoral spine ..	22·0	18·2	13·8	19·5	19·0	15·2
Length of pectoral	30·2	25·6	20·7	28·6	28·0	21·8
Length of pelvic	19·8	18·8	14·0	17·8	15·6	15·0
Length of nasal barbel ..	32·0	31·0	25·0	35·6	36·2	28·5
Distance between occipital process and dorsal fin	17·4	16·3	14·7	20·5	18·0	16·4

[1] The caudal fin is partly damaged in this specimen.
[2] This is a mature female full of eggs.

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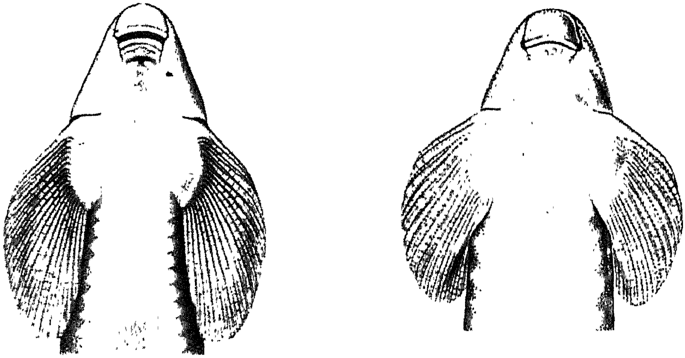
FISHES COLLECTED BY THE VERNAY-HOPWOOD UPPER CHINDWIN EXPEDITION, 1935.

BY SUNDER LAL HORA, D.SC., F.R.S.E., F.N.I., AND K. S. MISRA, M.SC. (*With one plate*).



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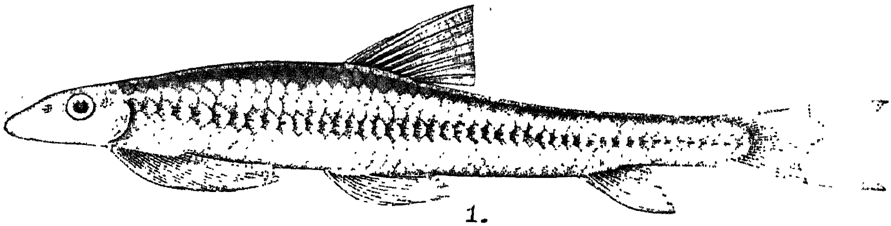

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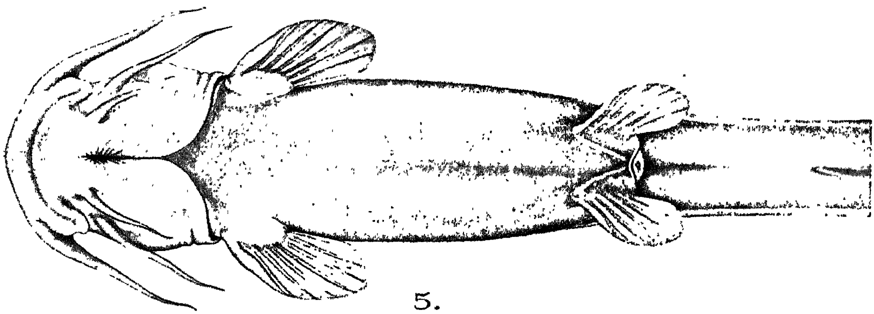

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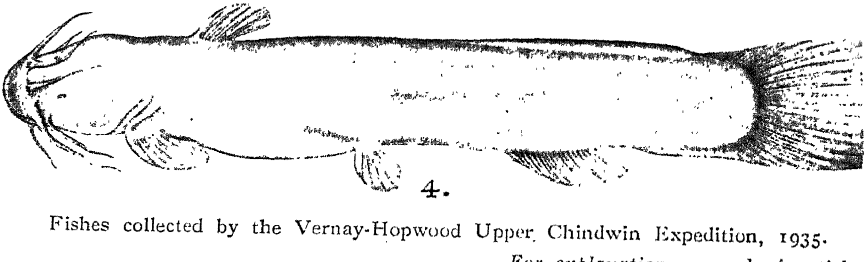

4.

Fishes collected by the Vernay-Hopwood Upper Chindwin Expedition, 1935.

For explanation see end of article.

[*From the* JOURNAL OF THE BOMBAY NATURAL HIST. SOC., *August* 1941.]

FISHES COLLECTED BY THE VERNAY-HOPWOOD UPPER CHINDWIN EXPEDITION, 1935[1].

BY

SUNDER LAL HORA, D.SC., F.R.S.E., F.N.I., AND K. S. MISRA, M.SC.,

Zoological Survey of India, Calcutta.

(*With one plate*).

The collection dealt with in this paper was received from two sources, but originally it had formed part of a much larger collection made by the Vernay-Hopwood Upper Chindwin Expedition. In June 1938, Mr. S. H. Prater sent to the Zoological Survey of India 42 specimens of fish which the Bombay Natural History Society had received as a presentation from the American Museum of Natural History. In August, 1938, Mr. J. T. Nichols of the American Museum of Natural History, on his own initiative, sent a small consignment of 50 fishes collected by Mr. H. C. Raven of the Vernay-Hopwood Chindwin Expedition. The latter lot comprised only such forms about the identification of which there were some doubts. The major part of the collection had, however, already been named and distributed on the shelves in the Museum. Of the specimens received from the Bombay Natural History Society there were some that had been collected by the Expedition in the Malay Peninsula, but we propose to deal here only with the specimens collected from the Chindwin drainage in Upper Burma. For precise data about the various localities from which the fish were obtained reference may be made to Morris's article in the *Journal of the Bombay Natural History Society* (vol. xxxviii, pp. 647-671, 1936) in which a general account of the Expedition is given.

We are given to understand that owing to unusual field difficulties of packing and transportation, the fish material could not be looked after properly and it is not surprising, therefore, that quite a number of specimens are in a poor state of preservation. However, it has been possible to identify all of them specifically.

In the following list species represented in the collection examined by us from the Upper Chindwin area are given; the localities in which the respective species were collected and their general distribution are also included.

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List of Species.

Specific Name	Locality and number of specimens	Further Distribution
Family FLUTIDÆ		
1. **Fluta alba** (Ziew).	Lonkhin: 5 specimens ...	Manipur, Assam; Burma; Malay Peninsula and Archipelago, Siam to Northern China; Chinese islands; Formosa and Japan.
Family MASTACEMBELIDÆ		
2. **Mastacembelus unicolor** (K. & V. Hass.).	Mawlaik: 1 specimen ...	Burma to Java.
Family CYPRINIDÆ		
Subfamily *Rasborinæ*		
3. **Danio aequipinnatus** (McClelland).	Kora: 14 specimens ...	India, Burma and Siam.
4. **Rasbora rasbora** (Hamilton).	Dalu: 6 specimens ...	India, Burma and Pihang.
5. **Barilius barna** Hamilton.	Upper Burma: 2 specimens ...	India and Burma.
Subfamily *Cyprininæ*		
6. **Barbus (Tor) mosal** (Hamilton).	Lonkhin: 1 specimen ...	India and Burma.
7. **Barbus (Puntius) sewelli** Prashad and Mukerji.	Dalu: 2 specimens ...	Myitkyina District, Upper Burma.
8. **Barbus (Puntius) ticto** Hamilton.	Dalu: 3 specimens ...	India, Burma, Ceylon and Siam.
9. **Labeo devdevi** Hora.	Dalu: 22 specimens ...	Chindwin Drainage, Assam; Burma and Siam.
10. **Psilorhynchus homaloptera** var. **rowleyi**, nov.	Kora: 3 specimens ...	...
11. **Rohtee cotio** var. **cunma** Day.	Kaunghein: 1 specimen.	Chindwin Drainage in Assam, Peninsular India and Burma.
12. **Rohtee feae** (Vinciguerra).	Kalawa: 3 specimens ...	Burma.
Family COBITIDÆ		
13. **Acanthopsis choirorhynchus** (Blkr.).	Kaunghein: 2 specimens.	Sumatra, Java, Borneo, Malay Peninsula, Burma, Siam and Annam.
14. **Lepidocephalus berdmorei** (Blyth).	Dalu: 1 specimen ...	Chindwin Drainage in Assam, and Burma.
Family ARIIDÆ		
15. **Arius jatius** (Hamilton).	Kalewa: 1 specimen ...	Estuaries and rivers of Bengal and Burma.

[2]

Specific Name	Locality and number of specimens	Further Distribution
Family SILURIDÆ 16. **Silurus cochinchinensis** Cuv. and Val.	Kaunghein : 1 specimen...	India, Burma, Malay Peninsula and Cochin China.
Family AMBLYCIPITIDÆ 17. **Amblyceps mangois** (Hamilton).	Kora : 2 specimens ; Hai Bum : 4 specimens ...	India, Burma, Siam and Malay Peninsula.
Family SISORIDÆ 18. **Exostoma vinciguerre** Regan.	Kora : 1 specimen ...	Upper Burma.
Family OPHICEPHALIDÆ 19. ***Ophicephalus gachua*** Hamilton.	Kora : 3 specimens ...	Throughout the Oriental Region.
Family NANDIDÆ 20. **Badis badis** (Hamilton).	Burma : 4 specimens ...	India and Burma.
Family AMBASSIDÆ 21. **Ambassis baculis** (Hamilton).	Kaunghein : 2 specimens.	India, Burma and Siam.

Most of the species are widely distributed in parts of the Oriental Region and do not require any further comments. Some of the species, such as *Barbus (Tor) mosal* (Hamilton)[1], *Barbus (Puntius) ticto* Hamilton[2], *Barbus (Puntius) sewelli* Prashad and Mukerji[3] *Labeo devdevi* Hora[4], *Rohtee cotio* var. *cunma* Day[5], *Rohtee feae* (Vinciguerra)[5], *Silurus cochinchinensis* Cuvier &

[1] Hora, S. L.—'The Game Fishes of India. X. The Mahseers or the Large-scaled Barbels of India. 3. The Mosal Mahseer, *Barbus (Tor) mosal* (Hamilton)'. *Journ. Bombay Nat. Hist. Soc.*, vol. xli, pp. 784-794 (1940). The measurements of the specimen from Lonkhin are given on page 789.

[2] Hora, S. L., Misra, K. S. and Malik, G. M.—'A Study of Variations in *Barbus (Puntius) ticto* (Hamilton)'. *Rec. Ind. Mus.*, vol. xli, pp. 263-279 (1939). The measurements, scale-counts and position of colour spots of the specimens from Dalu are given on page 274.

[3] Prashad, B. and Mukerji, D. D.—'The Fish of the Indawgyi Lake and the streams of the Myitkyina District (Upper Burma)'. *Rec. Ind. Mus.* vol. xxxi, p. 197, pl. ix, figs. 1, *1a*, *1b* (1939). *B. sewelli* is represented in the collection by juvenile specimens.

[4] Hora, S. L.—'On a Further Collection of Fish from the Naga Hills'. *Rec. Ind. Mus.*, vol. xxxviii, pp. 323, 324 (1936); 'Notes on Fishes in the Indian Museum. xxxii. On a Small Collection of Fish from the Upper Chindwin Drainage'. *ibid.*, vol. xxxix, p. 333 (1937). In the collection under report, *Labeo devdevi* is represented by juvenile specimens.

[5] Hora, S. L. and Misra, K. S.—'Notes on Fishes in the Indian Museum. XL. On Fishes of the genus *Rohtee* Sykes'. *Rec. Ind. Mus.*, vol. xlii, pp. 155-172 (1940). Measurements, number of anal rays, and scale-counts of the Kaunghein specimen of *Rohtee cotio* var. *cunma* are given on page 170, while those of the two specimens of *R. feae* from Kalawa are given on page 158.

Valenciennes[1] and *Exostoma vinciguerra* Regan[2] have already been dealt with in recent years, while notes on *Psilorhynchus homaloptera* var. *rowleyi*, nov. and *Amblyceps mangois* (Hamilton) are given below. The occurrence of *Arius jatius* (Hamilton) in the Upper Chindwin Drainage is of special significance, for though the species is known to ascend far above tidal reach its record from such great distance from the sea is rather unusual. As pointed out by Hamilton[3] the palatine teeth are entirely absent.

Psilorhynchus homaloptera var. **rowleyi**, nov.

Plate I, figs. 1 and 2.

In 1935, Hora and Mukerji[4] described a new species of *Psilorhynchus*, *P. homaloptera*, from the Brahmaputra Drainage of the Naga Hills, Assam. Next year, Hora[5] recorded two more specimens of the same species from this region. In the collection under report, there are three specimens from Kora which are generally similar to *P. homaloptera* (Plate I, fig. 3), but the body is only slightly depressed, the caudal peduncle is more slender and narrow, the head is somewhat more pointed, the interorbital space is narrower and the eyes are proportionately larger. We believe that these specimens represent a distinct Burmese variety of the species which we have named after Major Rowley, a member of the Expedition.

The differences noted above between the typical form from India and the Burmese variety are of the same nature as pointed out by Hora[6] between *Balitora brucei* Gray from India and its variety *burmanica* Hora from Burma.

[1] Hora, S. L.—'Siluroid Fishes of India, Burma and Ceylon. VII. Fishes of the genus *Silurus* Linnaeus'. *Rec. Ind. Mus.*, vol. xxxviii, pp. 351-56 (1936)

[2] Hora, S. L.—'Notes on Fishes in the Indian Museum. V. On the composite Genus *Glyptosternum* McClelland' *Rec. Ind. Mus.*, vol. xxv, p. 41, pl. iii, figs. 1-3 (1923).

Now that the generic limits of *Glyptosternum* McClelland have become sufficiently defined, we recognise the divisions into which this composite genus has been divided by Regan, Norman and Smith (*Journ. Siam Soc. Nat. Hist. Suppl.*, ix, p. 71, 1933). The generic appellation *Exostoma* Blyth is, however, inappropriate, for, as shown by Hora (*loc. cit.*, p. 3), its type-species belongs to *Glyptothorax* Blyth. Till fresh specimens of *E. berdmorei* Blyth become available, we do not wish to disturb the present nomenclatorial arrangement and have accordingly adopted the generic name *Exostoma* for *E. labiatus* Blyth and allied forms.

[3] Hamilton, F.—'*An Account of the Fishes found in the River Ganges and its tributary branches*,' pp. 171, 376 (Edinburgh, 1822).

[4] Hora, S. L. and Mukerji, D. D.—'Fish of the Naga Hills, Assam'. *Rec. Ind. Mus.*, vol. xxxvii, pp. 391-397, pl. vii, figs. 1-6 (1935).

[5] Hora, S. L.—'On a Further Collection of Fish from the Naga Hills'. *Rec. Ind. Mus.*, vol. xxxviii, p. 318 (1936).

[6] Hora, S. L.—'Classification, Bionomics and Evolution of Homalopterid Fishes'. *Mem. Ind. Mus.*, vol. xii, p. 291, pl. xi, fig. 6 (1932).

Measurements in millimetres.

Standard length	61·5	75·0
Length of head	12·0	14·0
Height of head	7·0	9·0
Width of head	10·0	11·0
Diameter of eye	4·0	4·5
Length of snout ...	5·0	6·3
Interorbital distance ...	4·9	5·6
Depth of body ...	9·5	12·0
Width of body ...	9·5	12·0
Length of caudal peduncle	10·5	11·0
Least height of caudal peduncle	4·5	5·5

Amblyceps mangois (Hamilton).

Plate I, figs. 4 and 5.

1933. *Amblyceps mangois*, Hora, *Rec. Ind. Mus.*, xxxv, pp. 607-621.

The specimens of *Amblyceps mangois* from Hai Bum are the largest yet recorded, the largest specimen being 163 mm. in total length. In these examples the head and the body are covered with a felt-like growth of papillae. The lips are also thickly papillated. The eyes are very minute, almost indistinguishable, and the caudal fin is truncate. The adipose fin is thick and low, and just forms a ridge.

Owing to their strong build, these specimens are liable to be confused with *Liobagrus* Hilgendorf, but can be readily distinguished on account of the respiratory structures associated with the gill-openings (*vide* Hora, *loc. cit.*, p. 612). The larger examples are superficially not dissimilar to *Glyptosternum* McClelland (=*Parexostoma* Regan), but the extent of the gill-openings, and the position and form of the various fins are sufficient to distinguish the two types of fishes.

The pelvic fins are close together on the ventral surface and are provided with muscular bases. Some of the specimens are heavily parasitised by worms which are encysted in the body wall and on the fins.

In recent years the range of distribution of *A. mangois* has been greatly extended. It is found in the Malay Peninsula, Burma, Siam, Assam Hills, Himalayas, Rajmahal Hills, Santal Parganas and the headwaters of the Mahanadi River.

Explanation of Plate

Fig. 1.—Lateral view of the type-specimen of *Psilorhynchus homaloptera* var. *rowleyi*, nov. × $1\frac{3}{8}$.

Fig. 2.—Ventral surface of head and anterior part of body of the same. × $1\frac{3}{8}$.

Fig. 3.—Ventral surface of head and anterior part of body of *Psilorhynchus homaloptera* Hora & Mukerji. × $1\frac{3}{8}$.

Fig. 4.—Dorso-lateral view of a specimen of *Amblyceps mangois* (Hamilton) from Hai Bum. × 5/6.

Fig. 5.—Ventral surface of head and part of body of the same. × *ca* $1\frac{1}{2}$.

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FISH OF POONA. Part II.

By Dr. S. L. Hora, D.SC., F.R.S.E., F.N.I. and K. S. Misra, M.SC. (*With one text-figure*).

[*From the* JOURNAL OF THE BOMBAY NATURAL HIST. SOC., *August* 1942.]

FISH OF POONA.

PART II.

BY

S. L. HORA, D.SC., F.R.S.E., F.N.I., and K. S. MISRA, M.SC.

(*Continued from page* 91 *of this volume*).

(*With one text-figure*).

LIST OF FISHES WITH THEIR HINDI NAMES AND DISTRIBUTION[1].

In the first article of this series, Fraser[2] gave a general account of the Poona waterways with descriptions of localities and lists of fishes collected from each, and here we give a complete systematic list of the species represented in the material along with their respective Hindi names and further distribution. Notes on the taxonomic position of certain species are included at the end. In preparing the list we have adopted the classification proposed by Jordan[3] and have given Hindi names collected by Mr. Fraser from 'Pardeshi Boies'. It will be seen that different species are sometimes called by the same name and that one species may sometimes have several different names. In making collections of fish, therefore, much reliance cannot be placed on the vernacular names given to various species. Limits of the distribution of each species are given with a view to show the geographical relationships of the fauna as a whole. Most of the species are widely distributed while a few are restricted to the Western Ghats and the neighbouring hill ranges.

The occurrence of *Schizmatorhynchus* Bleeker and *Mystacoleucus* Gunther is of special significance; besides the Western Ghats, the former is found only in the Malay Archipelago, while the latter is found in Burma, Siam, Malaya, etc. but nowhere else in India. These two genera show the Malayan affinities of the fauna of this part of the Western Ghats. *Labeo boggut* (Sykes) has also been recorded from the Malaya, but this requires further confirmation.

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[1] Published with permission of the Director, Zoological Survey of India.
[2] Fraser, A. G. L., *Journ. Bombay Nat. Hist. Soc.*, xlii, pp. 79-91, (1942).
[3] Jordan, D. S., *Classification of Fishes* (Stanford University: California: 1923).

Scientific Names	Hindi Names	Further Distribution
Order: ISOSPONDYLI Family: NOTOPTERIDAE		
1. **Notopterus notopterus** (Pallas)	Chalut.	India, Burma, Siam, Malay Peninsula, Malay Archipelago, Southern China (Yunnan) and Indo-China.
Order: OPISTHOMI Family: MASTACEMBELIDAE		
2. **Mastacembelus armatus** (Lacép.) ...	Bam.	Ceylon, India, Burma, Malaya, Siam, East Indies and China.
Order: APODES Family: ANGUILLIDAE		
3. **Anguilla bengalensis** (Gray) ... ... =**Anguilla elphinstoni** Sykes.	Aheer.	Ceylon, India, Burma, Java and Celebes.
Order: EVENTOGNATHI Family: CYPRINIDAE Subfamily: *Abramidinae*		
4. **Chela boopis** Day.	Barwah, Peurah, Barwa, Chindoor, Bharwah, Amblee.	South Canara and ? Mysore.
5. **Chela clupeoides** (Bl.)	Amblee, Kala Shurath.	Cutch, Peninsular India, Satpura Trend and Burma.
6. **Chela phulo** Ham.	Barwah, Phalgah, Ambli, Sufed Powwul, Kala Barwa, Kala Pirwah, Peurah, Dhansahree, Kala Ambli, Peelah Pirwah, Sufed Barwa, Peelah Powwul.	Assam, Bengal, Orissa, Central India, Deccan and as far southwards as the Tungabhadra and Kistna rivers.
Subfamily: *Rasborinae*		
7. **Barilius barna** Ham.	Theenohr.	Mysore, Orissa, Bengal, Assam and Burma.
8. **Danio aequipinnatus** (McClelland) ...	Thook Chatee, Dhandawah, Dhan, Bhatarsee.	Ceylon, India, Burma and Siam.
9. **Rasbora daniconius** (Ham.)	Loodeah, Ranjannah, Dhandawah.	Ceylon, India, Burma, Malay Peninsula, Southern China and Indo-China.

[3]

Scientific Names	Hindi Names	Further Distribution
Subfamily: *Cyprininae*		
10. **Barbus (Puntius) amphibius** (C.V.) ...	Danghar, Jhirwah, Bhatarseo, Dhan.	Ceylon and Peninsular India.
11. **Barbus (Puntius) chola** (Ham.) ...	Dhunsahree, Chulliah, Ghaar, Sahkar Massah, Dagh.	Ceylon, India, Burma, China and Indo-China.
12. **Barbus (Puntius) jerdoni** Day. ... =**Barbus dobsoni** Day. =**Barbus pulchellus** Day. =**Barbus jerdoni maciveri** Annandale	'Barsa', Seerahta, Soorookh, Gooroond, Khadra, Sufed Puree Khadree, Pahsoor.	South Canara and Deccan.
13. **Barbus (Puntius) kolus** Sykes. ...	Kholus, 'Khclsa' Rahoos, Tahrak, Kala Kholus.	Deolali, Central Provinces, Deccan and throughout the Kistna and Tungabhadra and Godaveri rivers.
14. **Barbus (Puntius) sarana** (Ham.) =**Barbus (Puntius) chrysopoma** C.V. =**Barbus (Puntius) pinnauratus** Day.	Lall Purree Khadrie, Safed Puree Khadrie, Shoor, Soorookh, Kangoor, Kharook, Pahrand, Lall Pahrass, Shaar.	Ceylon, throughout India, Burma and China.
15. **Barbus (Puntius) ticto** Ham. ...	Debree, Chatee Debrie, Koondah.	Ceylon, India, Burma and Siam.
16. **Barbus (Tor) khudree** Sykes. ...	Phirkee, Barsa, Dart.	Ceylon, Peninsular India, Deccan and Satpura Trend.
17. **Cirrhina fulungee** (Sykes) ...	Lowlee, Powndah, Preeth, Peelah Soorookh, Peela Kholus, Soorkee, Dheer, Phirkee, Peelah Shurath, Soor, Ghoree.	Mysore and Deccan.
18. **Crossochilus latius** (Ham.) ...	Lahoor, Loodeah, Nahmooneah.	The Ganges and the Brahmaputra systems in Northern India and Peninsular India.
19. **Garra mullya** (Sykes) ...	Mallia, Mallah, Nakhta Mallia, Kala Shurath.	Kathiawar, Peninsular India and the Satpura Trend.
20. **Labeo boggut** (Sykes) ...	Gohrah, Ghor.	Central and South-west India generally and also in Malaya.
21. **Labeo calbasu** (Ham.) ...	Cowchee.	India, Burma and China.
22. **Labeo fimbriata** (Bl.) ...	Tamthee.	Sind, Punjab, Southern India at least to Orissa, probably N. E. Bengal; not recorded from Malabar and Canara.

23. **Labeo potail** (Sykes) ... ... =**Labeo porcellus** (Heckel)	'Tamthee', Lahhoor, Khandwee, Ghobree, Cowwool, Preeth, Cowchee, Shook, Tooth, Jhawal, Gobrie, Chakta, Tahmoshee, Thamooshee.	Ceylon and Peninsular India.
24. **Mystacoleucus ogilbii** (Sykes)[1]	Bakhar Massah.	Deccan, the Kistna and Godavari rivers.
25. **Parapsilorhynchus tentaculatus** (Annan.)[2] ...		Satpura Trend as far as Pachmarhi.
26. **Rohtee cotio** var. **cunma** Day[3]	Deotee, Goordee.	Sind, Deccan, Orissa, Assam and Burma.
27. **Rohtee neilli** Day	Deotee	Deccan and Travancore.
28. **Rohtee vigorsii** Sykes	Goordee.	Deccan, Kistna and Godavari rivers to their terminations.
29. **Schizmatorhynchus (Nukta) nukta** (Sykes)[4].	Dhotowandee.	Mysore and rivers of the Deccan.
Family: COBITIDAE		
30. **Lepidocephalus guntea** (Ham.) ...	Mohra gotia.	Throughout India (except to the south of the Kistna and along the Malabar coast).
31. **Nemachilichthys ruppelli** (Sykes) ...	Soondeah Garah.	Deccan.
32. **Nemachilus botia** var. **aureus** Day ...	Gotia Garah, Moorah gotia, Mohroogotia.	Deccan, Assam, upper portions of the Ganges and Jumna rivers.
33. **Nemachilus dayi** Hora[5]	Thaylia, Kala Mooroong.	
Order: NEMATOGNATHII		
Family: SILURIDAE		
34. **Callichrous bimaculatus** (Bl.)	Goongwaree.	Ceylon, India, Burma, Siam, Java, Borneo, Chusan, Yunnan and Indo-China.
35. **Callichrous pabo** (Ham.)	'Goongwaree', Kalie Goongwaree.	Jumna and Ganges rivers, Burma and Indo-China.
36. **Wallagonia attu** (Bl.)	Pahree.	Ceylon, India, Burma, Siam, Java, Sumatra and Western Yunnan.
Family: BAGRIDAE		
37. **Mystus cavasius** (Ham.)	Tengnah, Kala Tengnah, Singhara.	India, Burma, Siam, China and Indo-China.

[1] Hora, S.L., *Rec. Ind. Mus.*, XXXIX, pp. 311 (1937).
[2] Hora, S.L., *Rec. Ind. Mus.*, XXVII, p. 457 (1925).
[3] Hora, S.L. and Misra, K.S., *Rec. Ind. Mus.*, XLII, pp. 168–171 (1940).
[4] Hora, S.L., *Rec. Ind. Mus.*, XLIV, pp. 1–14 (1942).
[5] Hora, S.L., *Rec. Ind. Mus.*, XXXVII, p. 57 (1933).

[6]

Scientific Names	Hindi Names	Further Distribution
38. **Mystus gulio** (Ham.)	Kala Tengnah.	Ceylon, India, Burma, Siam, Malay Peninsula, Malay Archipelago and Indo-China.
39. **Mystus seenghala** (Sykes)	Chootkah.	India, Burma and China.
40. **Rita hastata** (Val.)		Deccan, the Tungabhadra and the Kistna rivers.
41. **Rita pavimentata** (Val.)	'Googoorah'.	Deccan, affluents of the Kistna.
Family: SISORIDAE		
42. **Gagata itchkeea** (Sykes).[1]	'Padhnah'.	Deolali, Satara and the Cauvery in the Coorg State.
43. **Glyptothorax conirostre** var. **poonaensis** Hora.[2]	Phather Chatoo.	Poona and its environs.
44. **Glyptothorax lonah** (Sykes)		Deccan, Godaveri river near Nasik and Bastar State (Central Provinces).
Family: SCHILBEIDAE		
45. **Proeutropichthys taakree** (Sykes)[3] ...	Moonia.	Peninsular India (except Malabar coast), Burma and ? Calcutta.
Family: PANGASIDAE		
46. **Silonopangasius childrenii** (Sykes)[4] ...	Seelundh.	Deccan.
Order: CYPRINODONTES Family: CYPRINODONTIDAE		
47. **Aplochilus lineatus** (C.V.)	Jhir, Konkani Garah.	Ceylon, Peninsular India and Deccan.
Order: SYNENTOGNATHI Family: XENENTODONTIDAE		
48. **Xenentodon cancila** (Ham.)	Denghwah.	Ceylon, India, Burma, Siam, Malaya and Indo-China.
Order: LABYRINTHICI Family: OPHICEPHALIDAE		
49. **Ophicephalus gachua** (Ham.) ...	Dhakoo, Murral.	Baluchistan, Afghanistan, Ceylon, India, Burma, Malay Peninsula, Siam, Malaya, Archipelago, Yunnan, Hainan and Indo-China.

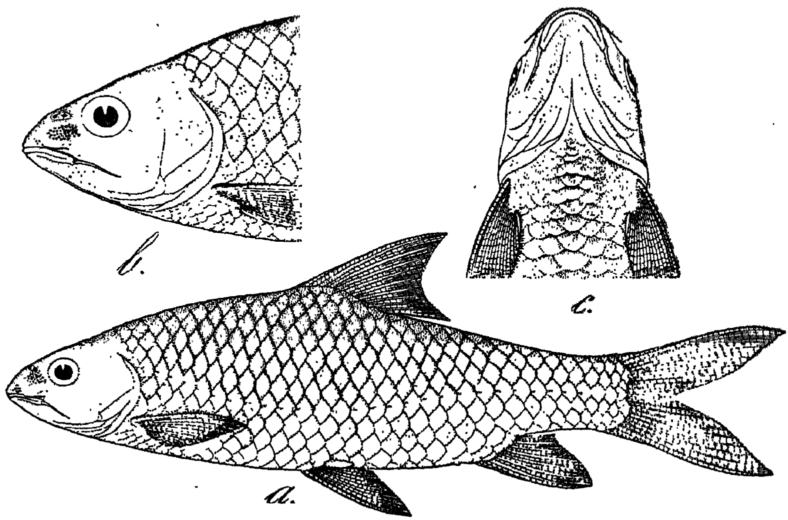
50. **Ophicephalus leucopunctatus** (Sykes) ...	Murral.	Peninsular India, Deccan, and also said to be found in China.
51. **Ophicephalus marulius** (Ham.) ...	Powndah, Murral.	Ceylon, India, Burma, Siam and China.
Order: PERCOMORPHI Family: AMBASSIDAE		
52. **Ambassis ranga** (Ham.)	Khardoo, Chandwah.	India, Burma, Malay and Siam.
Order: GOBIOIDEA Family: GOBIIDAE		
53. **Glossogobius giuris** (Ham.)	Kharpa.	East Africa, Ceylon, India, Burma, Malay Peninsula, Malay Archipelago, Siam, China, Indo-China, Wake Island, Australia and Tahiti.

[1] Hora, S. L. and Law, N. C., *Rec. Ind. Mus.* XLIII, pp. 18–20 (1941).
[2] Hora, S. L., *Rec. Ind. Mus.*, XL, pp. 368–370 (1938).
[3] Hora, S. L., *Rec. Ind. Mus.*, XLIII, pp. 105–110 (1941).
[4] Hora, S. L., *Rec. Ind. Mus.*, XLIII, pp. 98–100 (1941).

Barbus (Puntius) jerdoni Day.

1870. *Barbus Jerdoni,* Day, *Proc. Zool. Soc. London*, p. 372.
1870. *Barbus pulchellus,* Day, *Proc. Zool. Soc. London*, p. 372.
1876. *Barbus Dobsoni,* Day, *Journ. Linn. Soc. London* (Zool.), xii, p. 574.
1919. *Barbus jerdoni* var. *maciveri*, Annandale, *Rec. Ind. Mus.* xvi, p. 137.

From a detailed study of the material, including types, of the above listed three species and one variety in the collection of the Indian Museum, we find that the descriptions of *Barbus jerdoni* and *B. dobsoni*, characterised by a smooth snout, are based on female specimens, whereas the other two forms with tubercles on the snout represent male individuals. An examination of a large series of specimens has shown that there are no other valid differences between these species and that the characters on which they have been dis-



Text-fig. 1.—A male specimen of *Barbus* (*Puntius*) *jerdoni* Day, showing patches of tubercles on the snout.
a. Lateral view. $\times \frac{1}{2}$; *b.* Lateral view of head and anterior part of body. $\times \frac{3}{4}$; *c.* Ventral view of head and anterior part of body. $\times \frac{3}{4}$.

tinguished intergrade. Except that the two sexes can be readily distinguished in the adult condition on the presence or absence of tubercles on the snout, we have not been able to find any other character to recognise them specifically.

Barbus (Puntius) sarana (Hamilton).

1822. *Cyprinus sarana*, Hamilton, *Fish. Ganges*, pp. 307, 388.
1842. *Barbus chrysopoma*, Cuvier and Valenciennes, *Hist. Hat. Poiss.*, xvi, p. 165, pl. ccclvi.
1865. *Puntius pinnauratus*, Day, *Fish. Malabar*, p. 209, pl. xv, fig. 2.

Several authors, including Day, *Fish. India,* p. 562 (1878), have commented on the close similarity between *Barbus sarana, B. chry-*

sopoma and *B. pinnauratus*. After an examination of large series of specimens of these three species in the collection of the Indian Museum from India and Burma, we are definitely of the opinion that they are synonymous. We have, however, found that the specimens occurring in northern India possess more scales along the lateral line (32-34) and in front of the dorsal fin (12) than those found in southern India and Burma (L. 1. 28-32; predorsal 10-12). This is significant, for a similar reduction in the number of scales has also been observed in the case of the Burmese and South Indian specimens of *Puntius ticto*[1], *Rohtee cotio*[2] and *Lissocheilus hexagonolepis*[3].

Labeo potail (Sykes).

1841. *Cyprinus potail*, Sykes, *Trans. Zool. Soc. London*, ii, p. 354.
1844. *Tylognathus porcellus*, Heckel, *Fische Kaschmir*, p. 385.

From an examination of a large number specimens of different sizes, we have found that in the young and half-grown individuals the rostral barbels, though small, are fairly well-marked. In older specimens these barbels are reduced or are totally absent. In some specimens only one rostral barbel is present. The maxillary barbels are small and are situated in deep groves; on account of their small size and position, they are likely to be overlooked. Sykes's description of *Cyprinus potail* from the Deccan was based on a specimen 10 inches in length and it is no wonder that he found the barbels absent. Heckel described his *Tylognathus porcellus* from Bombay and characterized it by the presence of barbels; he gives the length of his species as 7 inches. In view of our detailed observations as noted above, we are unable to recognise these two species as distinct merely on the character of the barbels and have accordingly relegated *T. porcellus* to the synonymy of *Labelo potail*.

[1] Hora, S. L., Misra, K. S. and Malik, G. M., *Rec. Ind. Mus.*, xli, pp. 263-279 (1939).
[2] Hora, S. L. and Misra, K. S., *Rec. Ind. Mus.*, xlii, pp. 166-171 (1940).
[3] Hora, S. L. and Misra, K. S., *Journ. Bombay Nat. Hist. Soc.*, xlii, pp. 316, 317 (1941)

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From the Journal of the Royal Asiatic Society of Bengal. Science.
Volume VIII, 1942.
ARTICLE No. 4.

Respiratory Adaptations of the South Indian Homalopterid Fishes.

By SUNDER LAL HORA *and* NIRMAL CHANDRA LAW.

In a recent paper, one of us [1] dealt with the taxonomy of the Homalopterid fishes known from Peninsular India, and discussed the zoogeographical significance of their occurrence in this part of the country. He described representatives of three genera, *Balitora* Gray, *Bhavania* Hora and *Travancoria* Hora, belonging to the subfamily Homalopterinae. Of these, *Bhavania* is unique among the Homalopterinae in having the gill-openings restricted to above the bases of the pectoral fins. In the Gastromyzoninae, however, several genera, such as *Gastromyzon* Günther, *Pseudogastromyzon* Nichols, *Neogastromyzon* Popta, *Beaufortia* Hora and *Sewellia* Hora, possess similarly modified gill-openings. Besides the reduction of the gill-openings, the structures associated with the mouth, such as lips, barbels, rostral groove, etc., have also undergone structural adaptations in connection with the respiratory needs of the respective fishes. In a general way these modifications were discussed by Hora [2] in 1932. In this communication we give in greater detail the various modifications in structure connected with the respiratory activities of the South Indian forms.

The respiratory movements of *Balitora brucei* Gray were described by Hora [3] in 1923. It was observed that under normal circumstances only a small upper part of the gill-opening, provided with a broad gill-membrane, was functional, while the lower portion was rarely, if ever, used. It was also found that the fish was capable of suspending its respiratory movements for fairly long periods and that whenever any undesirable object entered the mouth it was spouted out with considerable force and thrown away at a distance of an inch or so. In the case of *Hemimyzon yaotanensis*, Fang [4] observed that the fish 'keeps its head up and down in continuously harmonic motions with the closing and opening of the branchial valves and the ceaseless vibrating of the posterior vertical portions of the pectorals while in respiration'. Hora (*loc. cit.*, 1923, p. 594) found that during respiration the snout of *B. brucei* was slightly raised above the

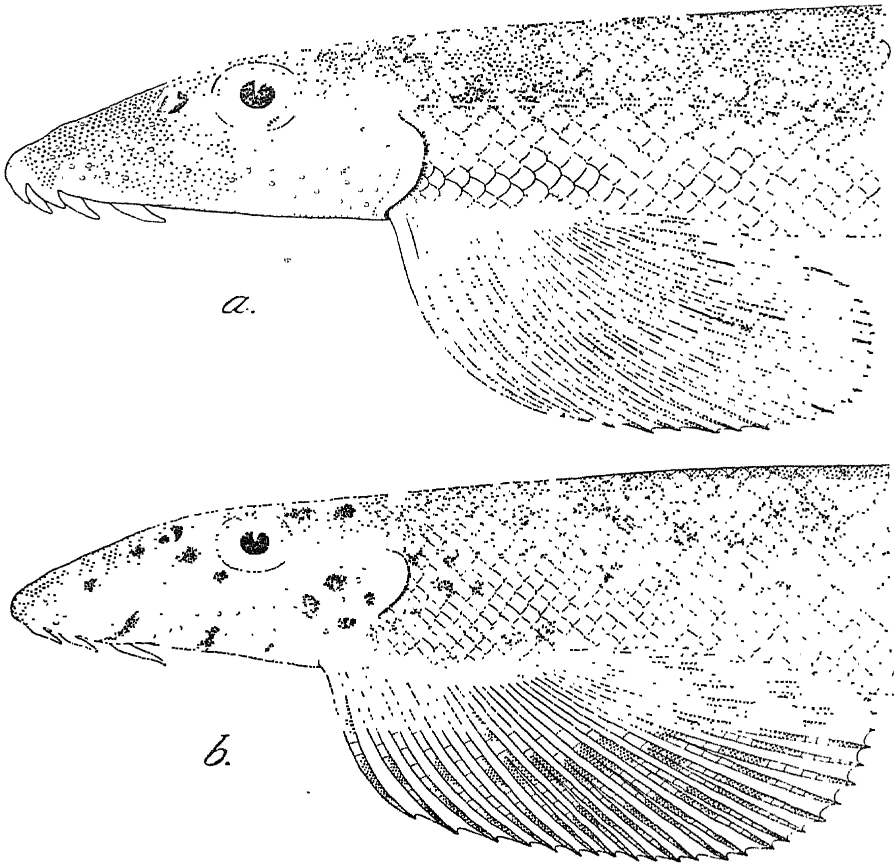
[1] Hora, S. L., *Rec. Ind. Mus.*, XLIII, pp. 221–232, pl. viii (1941). On pages 227 and 228, it is stated that the Sethumalai Hills are in Mysore. Mr. B. S. Bhimachar has kindly informed me that these hills form a part of the Anamalai Hills, which are situated to the south of the Nilgiri Hills.

[2] Hora, S. L., *Mem. Ind. Mus.*, XII, pp. 325–327 (1932).

[3] Hora, S. L., *Rec. Ind. Mus.*, XXV, p. 594 (1923).

[4] Fang, P. W., *Sinensia*, I, p. 142 (1931).

level of the substratum. He further remarked that 'It seems quite probable that the inner rays of the paired fins, which show



Text-fig. 1.—Lateral view of head and anterior part of body of *Travancoria* Hora and *Bhavania* Hora, to show the nature and extent of their respective gill-openings. $\times 3\frac{1}{5}$

a. Travancoria jonesi Hora; *b. Bhavania australis* (Jerdon).

peculiar movements, are used in driving away the excess of water that may enter below the fish from the anterior end. In still water these rays stop moving to and fro, thus showing that it is only in rapid water that their movements are useful to the fish. By continually pumping out the leakage water from underneath the fish they are directly helping the adhesive surface in the performance of its function. There is a regular channel at the base of pectoral fin along which the water moves before it is expelled at the posterior end and a current flowing in this groove

can be seen by placing a few drops of carmine solution near the anterior end of the base of the pectoral fin'. Thus the movements of the inner rays of the pectoral fins are not associated with respiration, but with adhesion by creating low pressure underneath the fish.[1]

At our request Mr. S. Jones conducted experiments on the respiratory movements of *Bhavania australis* in the Kallar Stream, about 30 miles north-east of Trivandrum, by using the same technique as employed in Hora's experiments on *Balitora brucei* (*loc. cit.*) and observed that

'Carmine powder placed under the anterior end of the fish is taken in and exhaled with the two tiny continuous streams which emerge from the small gill-openings. The respiratory movement is very fast, and its rate was not counted. When any large mass of foreign matter enters the mouth, it is spouted out with force. The movement of the posterior portions of the paired fins does not seem to have any relation to respiration for, when the fish is transferred to still water, this movement is stopped after a short time. Any slight disturbance in the water induces the resumption of the movement. In nature, whether the current is slow or fast, the posterior portions of the pectoral fins are always kept in motion. With the help of the paired fins, the fish gently crawls or glides forwards on the rocks. While breathing, the anterior lip is held just above the substratum, the four rostral barbels are directed towards the mouth, and the two maxillary barbels are directed outwards.

The fish does not suspend its respiratory movements either under water or outside of it. Though quite motionless otherwise, the fish, when lifted out of water by the tail, gasps for breath. When kept out of water, every drop of the liquid inside the gill-chambers is passed out first and afterwards air is taken in through the mouth and exhaled through the gill-openings. Fish taken out of water and held suspended by the tail is capable of living for 10–15 minutes, while if its mouth opening alone is under water the respiratory movements are not interrupted and the expiratory current continues to flow through the exposed gill-openings as two continuous streams. One of the fish was kept in this condition for 45 minutes and, though its surface dried up to some extent, it seemed to be quite healthy when returned to water.'

To comprehend fully the respiratory adaptations of the Homalopterid fishes, it is necessary to remember that these are greatly flattened forms in which the ventral surface and the paired fins, by which they adhere to rocks, are horizontal. The mouth is usually small and situated on the ventral surface considerably behind the tip of the snout. In swift currents there is a tendency among flattened organisms to obviate any flow of water underneath them, and this result has been accomplished in different ways. Among fishes, there are at least two genera, *Gyrinocheilus* Vaillant, a mountain carp known from Borneo and Siam, and *Arges* Cuv. & Val., a catfish of the Andes in South America, in which the mouth no longer serves as a passage for the inspiratory current. Here 'each gill-opening is divided into an upper slit-like portion, which serves as an inhalent opening and

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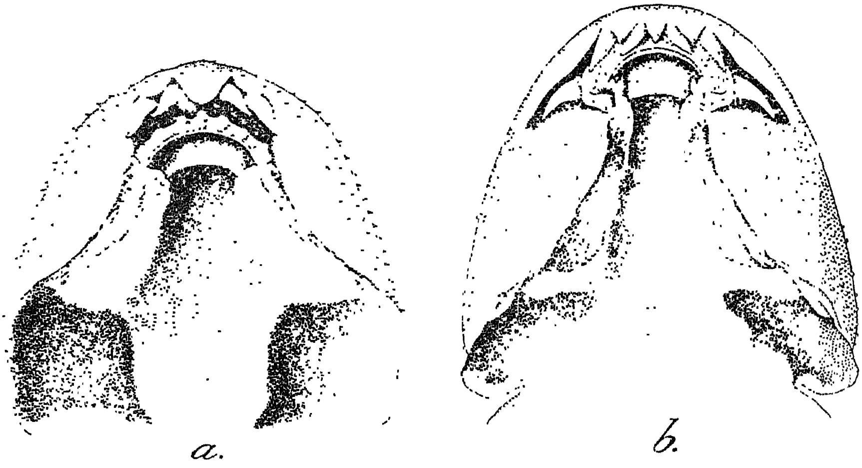
[1] Hora, S. L., *Phil. Trans. Roy. Soc. London* (B), CCXVIII, p. 259 (1930).

communicates with the posterior part of the mouth cavity immediately in front of the gills, and a lower much wider portion which serves as an exhalent aperture and is guarded by a large membranous flap'[1]. In the Homalopterid and other hill-stream fishes investigated by Hora (*loc. cit.*, 1923, pp. 591–596), the gill-openings are divided into an upper and a lower part, but both are meant for the passage of the expiratory current—the upper part is functional while the lower rarely, if ever, comes into play. However, one definite purpose is served even by this simple modification and that is this; the water of the expiratory current is not discharged on the ventral surface of the animal. The object of intermittent respiration seems to be to keep the anterior end closely applied to the substratum during the periods when the respiratory movements are suspended. The lower part of the gill-opening being useless becomes closed up and we get the evolution of the genera like *Bhavania*, *Gastromyzon*, etc.



Text-fig. 2.—Dissections from the ventral surface of the buccal cavity and gill-chambers of *Balitora* Gray and *Travancoria* Hora. ×3½.

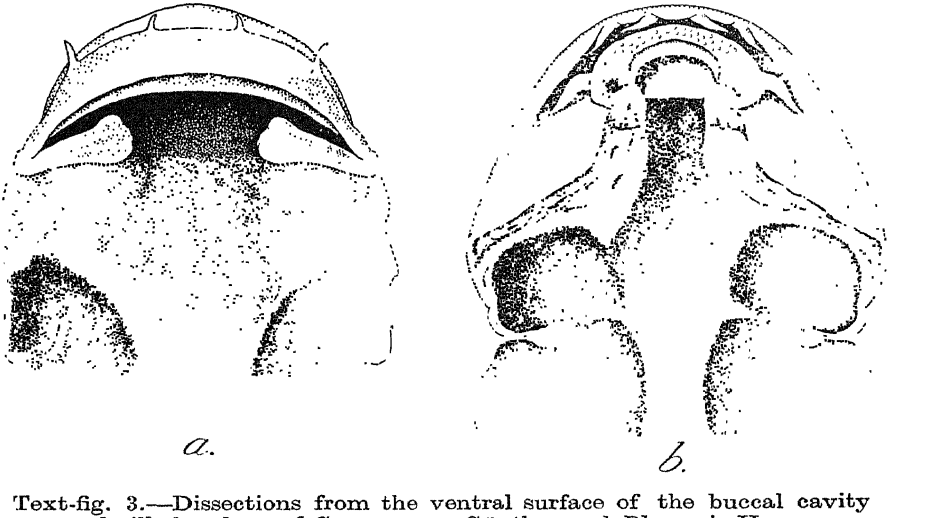
a. Balitora brucei Gray; *b. Travancoria jonesi* Hora.

The shaded parts represent the receptacles for the storage of water for respiration. Attention is also invited to the structure of the lips, rostral groove and rostral fold in the two forms.

With the reduction of the gill-openings and the small size of the mouth, it is obvious that the volume of the respiratory current is considerably reduced. One is led to the conclusion, therefore, that these fishes must possess some sort of receptacles

[1] Hora, S. L., *Journ. Bombay Nat. Hist. Soc.*, XXXVI, pp. 548–550 (1933).

for the storage of water, and on dissection it has been found that the pharynx and the gill-cavities have undergone certain modifications which enable them to store water. In *Balitora* and *Travancoria*, where the gill-openings are comparatively extensive, only shallow pouches are formed both along the roof of the mouth and in the gill-chambers, but in *Bhavania*, where the gill-openings are greatly reduced, the receptacles for water are well



Text-fig. 3.—Dissections from the ventral surface of the buccal cavity and gill-chambers of *Gastromyzon* Günther and *Bhavania* Hora.

a. Gastromyzon borneensis Günther. $\times 3\frac{4}{5}$; *b. Bhavania australis* (Jerdon). $\times 2\frac{2}{3}$.

The shaded parts of the buccal cavity and gill-chambers represent the receptacles for the storage of water for respiration. Attention is also invited to the structure of the mouth parts of these fishes.

developed. So the reduction of the gill-openings and the development of the large pharyngeal and gill spaces for the storage of water seem to go hand in hand. In *Gastromyzon* the head is so depressed and flattened that separate storage pouches are not formed but the whole of the buccal cavity and the opercular chambers form one large continuous reservoir. In the evolution of storage cavities, these torrential fishes show a parallel development to the air-breathing fishes of India,[1] such as *Periophthalmus* Bloch and Schneider, *Periophthalmodon* Bleeker, *Taenioides* Lacépède, *Apocryptes* (Osbeck) Cuv. & Val., *Pseudapocryptes* Bleeker, *Boleophthalmus* Cuv. & Val., *Pisoodonophis* Kaup and a host of other estuarine fishes, in which the pharyngeal lining and the gill-chambers serve

[1] Hora, S. L., *Trans. Nat. Inst. Sci. India*, I, pp. 1–16 (1935); *Proc. Nat. Inst. Sci. India*, V, pp. 281–287 (1937).

as the main respiratory organs. After taking in a gulp of fresh air, the type of air-breathing fishes enumerated above suspend their respiratory movements for fairly long periods. In this connection reference may be made to Hora's contention that the present-day diverse structures associated with aerial respiration in fishes seem to have developed originally to increase the area for aquatic respiration and only 'under adverse conditions of stagnation and drought, took up the function of aerial respiration. The accessory respiratory organs, however, can be used for both aerial and aquatic respiration under suitable conditions' (Hora, *loc. cit.*, 1935, p. 14). The above view has recently been confirmed by Wu and Liu [1] in their elaborate experimental studies on *Monopterus javanensis* (*Fluta alba*); they have also found that the bucco-pharyngeal epithelium, though habitually employed as the organ of air-breathing, proves effective for aquatic respiration also. Conversely, it should also be possible to keep torrential fishes alive in air provided their bucco-pharyngeal epithelium can be kept moist. Mr. Jones's experiments on *Bhavania* reported above clearly show that under adverse conditions the pharyngeal and gill pouches of the highly specialized Homalopterid fishes can subserve aerial respiration for short period or probably as long as their gills remain moist.

These results are of special value in elucidating the origin and function of the accessory respiratory organs in fishes.

It may here be noted that though normally all torrential fishes are water-breathers, during periods of drought when the streams are liable to break up into a series of pools and puddles, certain types,[2] such as *Amblyceps*, *Olyra*, *Lepidocephalus*, *Acanthophthalmus*, etc., with normal gill-openings, resort to aerial respiration. As pointed out by Hora,[3] under these conditions the epithelial lining of the buccal cavity and of the enlarged gill-chambers, though normally used for aquatic respiration, subserve aerial respiration.

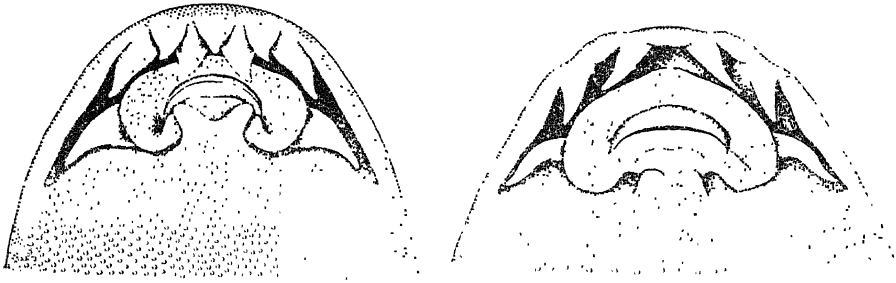
We have already pointed out that in the Homalopterid fishes the respiratory current enters through the mouth and for this reason the anterior end is slightly raised to allow the passage of water to the mouth. In a majority of the forms, there is a rostral groove in front of the mouth which is continued round the corners of the mouth into labial grooves and the radiating side channels diverging from them posteriorly. These grooves are no doubt developed to regulate the flow of water along definite channels and to prevent its spreading under the whole surface. In the rostral and labial grooves and on the lips surrounding the mouth barbels or other tentacular processes are developed for

[1] Wu, H. W. and Liu, C. K., *Sinensia*, XI, pp. 231–238 (1940). Also see review of it by Hora, S. L., *Curr. Sci.*, X, pp. 379, 380 (1941).

[2] Hora, S. L., *Trans. Nat. Inst. Sci. India*, I, pp. 11, 12 (1935).

[3] Hora, S. L., *Rec. Ind. Mus.*, XXXV, pp. 612–616 (1933).

testing the purity of the water that is used for respiratory purposes. In *Balitora brucei* the lips are continuous and strongly fringed all over, while in *Bhavania* and *Travancoria* the lips are so adapted that the water can only pass into the mouth, when it is applied to the substratum, from the sides of the middle part of the lower lip where gaps exist between it and the lateral parts of the lip. The middle part of the lower lip is



Text-fig. 4.—Ventral surface of the anterior part of head in *Travancoria* Hora and *Bhavania* Hora to show the nature of the mouth and the structure of the associated parts. × *ca.* 5.

a. Travancoria jonesi Hora; *b. Bhavania australis* (Jerdon).

The central portion of the posterior lip in these two forms is modified into two papilla-like structures which guard the entrances of the inspiratory current to the mouth. In figure *a* they are shown as plugging the inspiratory channels, while in figure *b* they are shown pulled backwards to permit the inspiratory current to enter the mouth.

provided with two well-developed papillae, which when thrust forwards, are capable of closing up the gaps, and when pulled backwards leave passages for the flow of the water into the mouth. The papillae are sensory and are capable of testing the water as it flows through the passages. The rostral barbels, 4 in *Bhavania* and 7 or more in two rows in *Travancoria*, also serve for testing the respiratory current. The lips are thick and papillated and would help to seal the mouth when the respiratory movements are suspended. The modifications of the mouth and associated structure are very diverse in the Homalopteridae, and serve as valuable diagnostic characters for distinguishing genera and species.

The respiratory movements of *Balitora*, *Hemimyzon* and *Bhavania* are discussed and correlated with the habitat and form of the fishes. It is shown that the movements of the inner rays of the pectoral fins are not associated with respiration. The probable causes which may have led to the reduction of gill-openings and the formation of receptacles for storage of water are explained. Attention is directed to the close parallelism

between the accessory respiratory chambers of the Homalopteridae and the bucco-pharyngeal chambers of certain air-breathing fishes of India. An account of the lips and associated structures of the Homalopteridae of South India is given and the probable functions of the various structures explained.

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HINTS ON FISH CULTURE IN INLAND WATERS

By Sunder Lal Hora, D.Sc.
Director of Fisheries, Bengal

ONE of the objects of the Department of Fisheries, Bengal, started in May 1942 under the prevailing abnormal and unsettled conditions, is 'to conduct investigations on tank fisheries with a view to increasing the food supply in the province, thereby aiding in the Grow More Food campaign'. It may here be recalled that the Royal Commission on Agriculture in India had pointed out in their Report (p. 495) that 'fish forms a specially valuable addition to a diet the staple of which is rice' and remarked that 'the development of inland fisheries in Bengal should be regarded as one of the most urgent measures of rural amelioration and we recommend that, if the financial position does not permit at present of the reconstitution of the department, at least one officer possessed of the necessary qualifications should be placed on special duty to promote interest among local authorities in the stocking of tanks with suitable fish and their conservation. The existing fishery departments in the Punjab, Bihar and Orissa and Madras should be strengthened for the same purpose.'

The development of inland fisheries is an all-India problem and under the prevailing emergency conditions has assumed a special significance. Owing to unavoidable restrictions on fishing in the estuarine and coastal areas and transport difficulties due to movements of essential war supplies, regional self-sufficiency in all important articles of food is highly desirable. Further, the principal species of Indian carp, such as *rohu* (*Labeo rohita*), *catla* (*Catla catla*), *mrigal* (*Cirrhina mrigala*), etc. are used for stocking tanks practically all over India and the methods of pisciculture practised in various provinces and states are not very different. I have thought it opportune, therefore, to outline in a series of short articles a few hints on fish culture in Indian waters with the object of inviting suggestions and criticism from those engaged in the improvement of this industry. No originality is claimed for these notes, which are based mainly on earlier literature on the subject and supplemented to a limited extent by personal observation in Bengal. It is hoped that the existing information will thus be codified and made available to persons interested in the development of inland fisheries.

At this season (February-March), the tanks are already stocked with fish, but the question of conservation of the available supplies and their increase is uppermost in the minds of fishery owners. It is necessary, therefore, to ensure that the fish live under healthy conditions and grow till they are marketed. In the first article of the series, therefore, observations are made on the seasonal epidemics of fish mortality in tanks which occur during the dry and hot months and remedial measures are suggested. It must be remembered that with the cessation of the monsoon, the water-level begins to fall and unless special precautions are taken certain tanks become foul and unsuitable for carp.

Epidemics of fish mortality

Throughout India, especially in Bengal and the neighbouring provinces, cases of sudden and widespread mortality among fishes living in tanks appear to be of common occurrence, and result in considerable economic loss. On a close investigation of two such epidemics which occurred in the tank in the compound of the Indian Museum, Calcutta, on 16 February 1926, and 14 and 15 August 1930, it has been ascertained that the primary cause of mortality is the decaying organic matter that accumulates at the bottom of old tanks. Shallow tanks which dry up during summer, or recently excavated tanks rarely, if ever, suffer from such epidemics of fish mortality. In old tanks, when the organic debris lying at the bottom putrefies, the dissolved oxygen in the water is used up and carbon dioxide and other poisonous substances, such as marsh gas, sulphuretted hydrogen, ammonia, etc. are produced. Under normal weather conditions, the loss of oxygen is made good by the absorption of the air at the surface and through the photosynthetic action of the green aquatic plants. Thus the normal exchange of gases keeps down the accumulation of poisonous substances below the limits at which they may prove lethal to the animals living in tanks. During the hot weather, however, the decomposition of organic matter is accelerated, and

under certain meteorological conditions, such as cloudy, sultry, and humid weather with high temperature, absence of rainfall, wind, etc., the process of putrefaction becomes still more marked with the result that the loss of oxygen cannot be made good and in consequence the accumulation of poisonous substances may reach lethal limits. The abnormal conditions thus produced cause 'asphyxia' among the animal population and the hunger for oxygen drives fishes and other unattached animals of mid-waters, such as prawns, to the surface, and the bottom-dwelling animals, such as molluscs, to the sides of the tanks. Under these circumstances, the fishes are seen swimming round and round at the surface in an uneasy manner, gasping for breath. If such symptoms are noticed in the earlier stages of the epidemic, it is usually not difficult to prevent heavy mortality of fish.

Remedial measures

The remedial measures that can be suggested fall into two categories, viz. mechanical and chemical.

Mechanical. The water should be stirred up by dragging a net through the tank ; this will not only effect a movement of the water resulting in its oxygenation and in the removal of a part of carbon dioxide and other poisonous substances, but some portion of the debris at the bottom may also be dragged out and got rid of. The water can also be stirred up by a number of persons swimming about in the tank or beating its surface with bamboo poles. If from a nearby source fresh water can be let into the tank, it will have an immediate beneficial effect by the dilution of the lethal substances and by adding more air to the water.

Chemical. In order to reduce the acidity of the water due to the absorption of carbon dioxide, organic acids, etc., the water may be treated with quicklime ($Ca\,O$) in small quantities so that its concentration in the water does not exceed 10 to 12 parts per million. On the basis of these figures half a seer of quicklime is sufficient for 1,500 c. ft. of water. The lime by mixing with the toxic substances will produce inert salts and thus lower the toxicity of the water. In the case of very foul waters potassium permanganate can also be used with great advantage. Being a powerful oxidizing agent, it oxidizes albuminoid ammonia and many harmful organic compounds. Its dose should not exceed $\frac{1}{8}$ grain per gallon, that is for 1,000 c. ft. of water 1·6 oz. is quite sufficient. Its administration to fishery tanks is generally helpful in killing various types of fish parasites and in the improvement of the sanitation of the tank. Ordinary washing soda, crude potassium carbonate (*sajji mati*) and wood-ash, especially of *deodar*, *chir*, and plantain plants, are also useful in reducing acidity.

Preventive measures

If preventive measures are adopted in time, such epidemics of mortality can be stopped altogether. At the commencement of the hot weather, February-March in Bengal, the bottom of old perennial tanks should be cleaned of organic debris by periodically dragging a net through the tank. This will, by stimulating the fish to activity, tend to maintain them in a healthy condition. Another advantage of periodic dragging would be to eliminate the predatory fishes, such as *saul*, *lata*, (*Ophicephalus* spp.), *chital*, *phaloi* (*Notopterus* spp.), etc. from the tank. Some of them are not affected by oxygen deficiency of the water as they possess accessory organs of aerial respiration, and after an epidemic of the kind described above they become a regular menace to the surviving fish and other useful organisms. Their eradication is highly desirable in the case of tank fisheries.

If the condition of the tank is so bad that all the measures suggested above prove ineffective and if the fishes planted in it show stunted growth it should be dewatered and the silt removed, and then treated as a new tank for fishery purposes.

As proper aeration of water is the most important factor for a healthy fishery tank, it is obvious that the tank must contain at all times a suitable quantity of water-weeds, such as *Wolffia* (*eedur kani pana*), *Lemna minor* (*kuti pana*), *Potamogeton crispus* (*pata jhanji*), *Ceratophyllum demersum* (*jhao jhanji*), etc. and chlorophyll-bearing algae, as under the influence of sunlight they will proudce oxygen and so maintain the necessary concentration of oxygen in solution in the water. It must also be remembered that water-weeds of various types and algae form the natural food of carps and thus their presence in tanks is also necessary for feeding fish. In no case, however, should a fishery tank have a thick surface-growth of coarse weeds and of rooted aquatics as, by screening off light, they produce vary unhealthy conditions in fishery tanks.

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ZOOLOGICAL RESEARCH IN RELATION TO DEVELOPMENT OF FISHERIES*

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IN inviting me to participate in a symposium on "Zoology and the Food Problem", our last year's President, Dr. B. N. Chopra, wanted me to elucidate "how zoological studies and research can help us in conserving, augmenting and utilising in the best possible way the fishery resources of India". My task has been made much easier by Dr. Chopra himself because in his Presidential Address, he brought out very ably the necessity and importance of scientific research in the development of fisheries. The members will also recall that at the Jubilee Session of the Congress held at Calcutta in 1938, the overseas and the Indian delegates of the Zoology Section reviewed the fisheries of the country in relation to food supplies and felt it necessary to urge upon the Government of India the desirability and "importance of constituting an All-India Department of Fisheries for the development of the fishery resources of Indian waters on scientific lines". The delegates were further of the opinion that, "unless development of the fishery resources of Indian waters is carried out with due regard to the scientific principles which form the basis of successful fishery developments, there will be grave danger of irreparable damage to the fisheries concerned". In commenting on the limited scope of the work done by the Fish Committee of the Imperial Council of Agricultural Research, Dr. Chopra advocated that—

> "Fishery research is a wholetime job and the problems connected with it are too numerous and too involved to be satisfactorily handled as a subsidiary activity of a section of the Imperial Council. Like agriculture, fisheries should have an Imperial Council of Fisheries Research under the scientific control of an expert Fisheries Officer, with a band of scientists working on its staff, with technologists trying to solve the difficulties experienced under varying conditions all over the country, with marketing experts always keen to devise means for better distribution and better utilisation, and with the whole body alive to the ideal of providing 'better food, more food, more and better fertilizer, better organization', and last but not the least, to the improvement in the moral and material conditions of the poor fishermen, for on his well-being will ultimately depend the prosperity of the industry."

Thus, it will be generally conceded that for the development of the fishery resources of India, there is an urgent necessity of undertaking scientific investigations on fishery problems by means of a carefully planned programme of co-ordinated scientific research, which, to be effective and efficient, should be controlled by one central authority for all India. I hope this Session of the Congress will also urge on the Government the necessity and importance of starting a central organisation for research in fisheries.

* An article contributed to the symposium on "Zoology and the Food Problem" held by the Section of Zoology and Entomology of the Thirty-first Session of the Indian Science Congress, at Dehli, in January 1944.

NATURE OF FISHERY INVESTIGATIONS

Confining myself now to zoological research in relation to the development of fisheries, I wish to invite your attention to the remarks made by the late Dr. N. Annandale regarding the nature of fishery investigations. According to him, these may be considered conveniently under two heads, (*a*) biological and (*b*) human.

> "Under the head 'biological', attention must be paid to the physical environment of the fish; to the fish themselves, their species, their life-history, breeding-habits and food, their enemies and, in the case of rapacious fish, their prey.
>
> "Under the head 'human', one must take into account methods of capture, fishery statistics, fishery laws and customs, customs and regulations as to the sale of fish, prices, demand, even the character and social status of the fishermen."
>
> "In all fishery questions it is of the first importance that due consideration should be given to all of these points and neither the human side of the enquiry sacrificed to the biological, nor, as is more common, the biological to the human. Biological training does not give a man local experience; it may not even make him a good judge of character, but still less does local knowledge or administrative capacity enable a man to speak sensibly on technical subjects such as biology without profound study."—(*A Note on the Fisheries of the Inlé Lake, Southern Shan States*, Rangoon, 1917, p. 1.)

ZOOLOGICAL STUDIES AND FISHERIES

In the light of these observations, let us now analyse how zoological studies and research can help us in the development of fisheries.

Environment of the Fish.—We all know that environment plays an important role in the life of an organism and that its rate of growth, health, longevity, etc., can be greatly influenced by making suitable alterations and adjustments in its environment, both physical and biological. For increasing the yield of our fisheries, it is necessary, therefore, that all factors that constitute the environment of any particular species should be studied and their influence on its well-being elucidated. For instance, in European countries through the accumulation of a vast body of accurate knowledge regarding the hydrography of the seas, the chemistry and physics of sea-water, its circulation, currents, seasonal changes and fluctuations in the water, and the planckton, both animals and plants, and its annual changes,

rapid progress has been made in fishery science and most of the problems which the European fisheries present are now well understood. The problems of the marine fisheries of India are similar and, therefore, for their elucidation a study of all the ecological factors influencing changes in the fish populations is most essential. In the case of freshwater fisheries, it is well known that all pieces of water are not equally productive and that through manuring the tanks and artificial feeding of fish poor tanks can be readily converted into good fisheries. The sources of river pollution and the means to prevent it, and the construction of suitable fish passes in irrigation and hydro-electric weirs to ensure the free movements of migratory fishes are all problems of environment which need a careful study of the habits of fishes at the hands of zoologists before engineers can devise suitable measures for the conservation of fisheries. In all such studies, the role of the zoologists is to correlate the bionomics of any particular species of fish with the physical and biological factors in its environment. There is no doubt that in some cases collaboration and help of chemists and physicists is needed to understand properly the physical environment of a fish, but of late the bases of zoological teaching have been so broadened that several zoologists have qualified themselves for undertaking research in these lines also.

Systematics of Fishes.—The value of the systematics of fishes in the development of fisheries is generally underestimated, but a slight reflection will show that unless we can differentiate species, any real progress in ecology and bionomics of the food fishes is not possible. It is worthwhile to recall that in considering practical measures, which should be adopted for the development of fish industry in India, the *Ad hoc* Fish Committee of the Imperial Council of Agricultural Research in its meeting held in November 1937, expressed the opinion that—

"In order to effect development upon satisfactory lines, it was necessary to carry out local surveys of the amount and class of fish available and in this connection proper identifications of the fish caught in each area was essential."

I can perhaps illustrate this point better by referring to the Hilsa fishery of India (*Journ. Roy. As. Soc. Bengal*, Science, VI, No. 2, pp. 93-112, 1941). We have found this species breeding under different conditions of salinity right from the deltaic region of the Ganges to as high up as Allahabad. We have also found that the Hilsa of East Bengal is somewhat different looking from the specimens taken from the river Hooghly at Calcutta. So the question naturally arises, are we dealing with one or more species under *Hilsa ilisha* (Hamilton)? On the analogy of Herring-fisheries in European waters and on the basis of our studies, European and American fishery experts have already surmised that there may be different races of Hilsa in our waters which breed under different environmental conditions. Hilsa, as we all know, is essentially a marine fish of the Herring family and, as at present understood, is known from the Persian Gulf, where it ascends into the Tigris river; from the coast of Sind, where it forms an important fishery in the Indus river and the Bay of Bengal whence it ascends into all the principal rivers of India and Burma. It is quite possible that different varieties and races of this species are found in Indian waters, but this point has not been investigated so far. Unless we thoroughly understand the systematics of this species, work on its ecology and bionomics for the proper management of its fishery may prove to be misleading.

It will thus be conceded that taxonomic studies form the bed-rock for all aspects of fishery research and development, and for these studies a sound knowledge of zoological science is most essential.

Breeding Habits and Life-Histories.—It is generally realised that for the development of the fishery resources of freshwaters, the establishment of hatcheries for the restocking of tanks, reservoirs, rivers, etc., and the framing of legislation to prevent interference with the spawning of freshwater fishes and the destruction of fry are some of the necessary measures which should be adopted. In recent years, these very measures have been advocated for the development of some of the marine fishery resources also. Even a very casual consideration of the above-mentioned problems will show the great need of zoological research, for without the knowledge of the breeding habits and life-histories of fishes, administrators are bound to commit several blunders in framing or administering fishery laws. I shall just cite one instance which will make this point clear. In the Inlé Lake, Southern Shan States, Burma, there are several species, about two dozen, which do not attain more than a couple of inches in length. There is an extensive and lucrative fishery of these small fish which yields a handsome revenue to the Government. Some administrator thought that these 'young' fish should be protected but the timely researches of the late Dr. N. Annandale (*Rec. Ind. Mus.*, XIV, P. 33, 1918) showed that these were adult fish and the fishery could continue without causing any deleterious effect to the productivity of the lake. "Close seasons to prevent annihilation of a species should always be based on research into the reproductive habits of the fish in question and disputes between owners of different types of gear can only be settled after attention to research on the swimming habits of the fishes taken by them" (P. E. P. Deraniyagala, *The Fisheries of Ceylon*, p. 8, Colombo, 1932).

The necessity and importance of the studies on the breeding habits and life-histories of all important food fishes for the development of fisheries is so obvious that I need not dwell any further on this point. Suffice it to say that these studies constitute purely zoological research which can be carried out best by specially trained fishery zoologists.

Biology of Fishes.—Under this heading we may consider all problems connected with food, growth-rate, enemies, parasites, migrations, and so on. The question of natural and artificial foods for fishes, especially in fish farms, is of

vital importance. We as zoologists know that all animal actions are determined by three main impulses, search for food, protection from enemy and propagation of the race. Several important fisheries depend upon the relative abundance and scarcity of food and the annual and periodic fluctuations in their yields are mainly influenced by the amount of food available in any particular year.

The biological problems enumerated above are more particularly concerned with freshwater fisheries where large number of fish are very often kept in a limited space, and where growth-rate, food, enemies and parasites can be controlled through the application of approved methods of fish farming. In the case of India the freshwater fisheries are of special significance from the standpoint of ameliorating the condition of the rural population.

"Human" Aspect of Fisheries

It has been shown above that in dealing with the 'biological' investigations connected with the development of fisheries, zoological studies and research have an important role to play. Even for the elucidation of the items listed by Annandale under "human", it will be noticed that a statistician with a zoological training will be able to collect more reliable fishery statistics than a person without any training to differentiate species or without any knowledge of the problems discussed above. For devising more suitable methods of capture, a knowledge of the swimming habits of fishes and the direction of migration will be of inestimable value. Similarly for devising fishery laws or regulations as to the sale of fish, a fair knowledge of the ecology and bionomics of fisheries is essential for suggesting effective measures.

It will thus be seen that for practically every aspect of fish production and conservation, zoological studies and research from the basis of an up-to-date fishery management. However, when we come to the utilisation of the product, zoologists need the help of technologists and marketing experts. Even here much better results can be expected from persons with a certain amount of zoological training and biological outlook.

Importance of Fisheries as a Source of Food

Having discussed the close relation that exists between the development of fisheries and zoological research and in view of the fact that the subject of the symposium is Zoology and the Food Problem, I wish to say a few words about the importance of fisheries as a source of food. As man must get his food either from land or aquatic sources, there are correspondingly two basic food industries, one comprising agriculture and animal husbandry, and the other, fisheries in a broad sense. The aquatic foods have one great advantage that they contain all the essential food elements, such as vitamins, minerals and proteins. It is necessary, therefore, that our fishery resources should be properly husbanded so that in times of emergency, like the present, they can be utilized very fully to supplement the deficiencies and failures of crops and food from the land. In their present undeveloped state, it is estimated that the value or primary production from fishing and hunting is only 120 millions of rupees and that the total catch of fish is 7,000,000 tons which, according to Dr. Radhakamal Mukerjee, yield ·7 billion calories as against the total requirement of the Indian population amounting to approximately 292 billion calories per annum, allowing 2,800 calories per man per day. These data indicate very clearly the great necessity of augmenting the present yield from our fisheries which are potentially very rich.

Importance of Fish in Indian Diet

As fish forms a specially valuable addition to a diet the staple of which is rice, it will be seen that its demand is greatest among the rice-eating population of India. For the same reason, in the countries of eastern and south-eastern Asia, and the adjacent great islands, the fisheries have always been of peculiar importance; since the mass of the people prefer fish to any other form of animal protein. In the north-western parts of India, where wheat forms the staple article of diet, dairy products and meat provide animal proteins in the dietary, while as we proceed eastwards along the Ganges or southwards to the peninsula, where rice forms the staple diet, dairy products become of less importance in the dietary, but fish, oil and root and leafy vegetables are in greater demand. In these parts of India even small fishes, which are good sources of protein, and sometimes of vitamin A, calcium and other inorganic elements, are consumed by non-vegetarian castes in fair quantities. From the dietetic surveys so far carried out in India, it seems that the conservation of fisheries and the greater use of fish as a principal article of diet are indispensable for the health of the nation.

Summary

Attention is directed to the necessity and importance of scientific research in the development of fisheries and it is indicated that nothing effective can really be done in India until there is a central organisation for fishery research. Reference is made to the nature of fishery investigations and it is shown how problems connected with the studies on the environment of fishes, systematics of fishes, breeding habits and life-histories, food, growth-rate, enemies, parasites, migrations and so on are dependent on zoological research for their proper elucidation. Even such items of fishery management as fishery statistics, fishery legislation, marketing, etc., can best be done by persons with zoological training and biological outlook. Thus in practically every aspect of fish production and conservation, zoological studies and research have an important role to play.

Reference is made to the importance of fisheries as a source of food and to the present-day estimated yield from Indian fisheries. The importance of fish in certain Indian diets is also indicated.

HINTS ON THE CULTURE OF MURREL

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THE *murrel* is the *Ophicephalus* or snake-headed fish of the ichthyologist. This genus is widely distributed in the fresh-waters of eastern and south-eastern Asia, Indo-Australian Archipelago as far east as Halmahera, and tropical Africa. There are several species in the genus, but the designation *murrel* is applied to two, *O. marulius* Hamilton and *O. striatus* Bloch, which grow to two or three feet in length and are not bad eating inspite of numerous bones. Its general habits are very much like those of an English pike.[1]

Characteristics

The *murrel* feeds mostly on frogs, but insects and other live food are also taken. The *murrel* and allied fishes are characterized by the possession of a suprabranchial cavity which is in open communication with the pharynx and is provided with mucous membrane adapted for aerial respiration. In consequence, the *murrel* can live a long time without water and can, therefore, be transported alive and in a fresh condition over long distances. In fact, ' in China they are often carried alive in pails of water, and slices are cut off for sale as wanted, the fish selling dear while it retains life, while what remains after death is considered as of little value '[2].

' The *murrel* unlike most fish, exhibits parental affection towards its young, keeping them together in a shoal, and swimming under them, and attacking anything that comes near them. This it does till they are about three inches long, when it turns on and eats them itself, if they do not disperse. '

Table qualities

In certain parts of India, especially the Punjab, Central Provinces and Hyderabad State, *murrel* is regarded as an excellent fish for the table and during the war, even in Bengal where it is not so highly prized as carp, it is now being supplied to the Army as a B.T. ration under the name ' black mullet '. In certain provinces *murrel* fetches a much better price than *rohee* (*Labeo rohita*), *catla* (*Catla catla*), and other carp. In the Punjab, there is a popular saying '*machhi khaiye sol baki sub makhol*' (the only fish worth eating is *sol* (*murrel*), other kinds are merely an apology for fish). On account of heavy demand for the *murrel* and the ease with which the fish can be transported and bred, Madras, Punjab and Bombay attempted its culture on an experimental scale but without success.

Abortive experiments

Under the 'grow more food' campaign further attempts are likely to be made to culture this fish, so I wish to place on record the results of the experiments conducted so far in order to avoid disappointment in future.

Madras: In Madras, ' The earliest experiments in Sunkesula farm were in *murrel* breeding. Though the eggs of *murrel* are easiest to collect and hatch, the larvae after a certain stage are exceedingly difficult to rear on account of the specialized live-food they need. Adult *murrel* also thrive on live-food and never keep in condition on a diet of artificial food in ponds. To maintain a few select breeders in special ponds with shallow margins and an abundance of weeds suitable for nesting on a diet of live minnows, carp and frogs and annually to transplant the fry obtained to extensive marshes with rank vegetation teeming in worms, insects and frogs was found to be the best method of cultivating them.'[3]

In view of the above, the Madras Fisheries Department found the turning of the *murrel* fry into a natural shallow swamp with abundant vegetation, insect larvae and crustacea to be the best method of cultivating this fish.

' Accordingly an extensive swampy waste (The Edurur swamp) about six miles from Sunkesula required neither for cultivation nor for the culture of other food-fish was reserved as a nursery and feeding ground for *murrel*. The young hatched and turned out in the swamp are annually fished and stored in ponds for a

[1] Thomas, H. S.—*Rod in India* (Mangalore, 1873) pp. 124-133.

[2] Hamilton, F.—*Gangetic Fishes* (Edinburgh, 1822) p. 59.

[3] Anon—*Report of the Committee of Fisheries in Madras*, 1929, p. 152.

regular supply of live *murrel* to the Kurnool market at seasons of the year when fresh fish are not available in that inland town.'[1]

Punjab : For results of experiments conducted in the Punjab, attention is invited to the *Report of the Department of Fisheries*, Punjab, beginning with 1926, though the experiments were commenced in 1913 in the Sirkian tank along the Upper Bari Doab Canal about seven miles from Gurdaspur and in 1917 at Madhopur. The fish spawned successfully every year, but its culture proved a failure as the following extracts from the reports will show:

Madhopur : Here the results are no more satisfactory than elsewhere. We can breed *murrel*, but we cannot keep them. In the past years Mr Hamid Khan, M.Sc., Superintendent of Fisheries, has carried out a large number of experiments and recorded most interesting data on the life history of *murrel* from the egg stage upwards, but so far as stocking operations go, we can record nothing but failures.

'From May to July (1925) 5 pairs of *murrels* spawned in our tanks and various food experiments were tried with fry set apart for the purpose. They were fed on (a) goat's liver, (b) goat's liver and silk-worm cocoons in equal parts, (c) goat's liver, silk worm cocoons and wheat flour in equal parts and (d) on silk-worm cocoons and wheat flour in equal parts and growth watched and it was found that those fed on goat's liver showed the most rapid and uniform growth, whereas those on silk-worm and wheat flour proved the weakest of the lot.'

'Seven hundred and sixty of the more robust fry were eventually turned loose in the lower tank. This year, in April, the tanks were emptied and only 46 fish varying from 14 in. to 28 in. and 6 small fry of 6 in. to 7 in. were recovered from both tanks. The rest had probably been devoured by the bigger ones, which goes to show that this is not a fish for stocking waters, unless they (waters) are very extensive and the fry have plenty of range to escape from the bigger fish, which can also find other forms of food.'[2]

'The results of the *murrel* breeding experiments have been rather disappointing. Two pairs spawned during May and June, 1926, laying about 2,300 eggs out of which 406 fry only survived. These were kept apart in a portion of the lower tank. During January and February, 1927, there was a heavy mortality among the fry and the adult fish. Almost all the fry and 27 of the adults died. The dead fish were examined by the Superintendent and nothing wrong was found in them internally or externally. The death appeared to be due to severe cold and hail-storms which rendered the water very cold. One pair of *murrel* has spawned on 20 May, 1927, and if the results do not prove any better this year, the experiments with this species will be discontinued, and both the tanks at Madhopur will be utilized for *mahasir* breeding.'[3]

'Again as stated in last year's report, the Madhopur tanks have been cleared of *murrel*, and *mahasir* have been substituted. The remarks contained in our last report with regard to the experiments with *murrel* have been somewhat misconstrued. It is not so much the experiments which have been disappointing as the fish. We have succeeded in getting them to spawn each year, and have sent their fry to stock other waters, and in so far we have been successful, but where our experiments have been disappointing is that they have led to nothing, owing to the predatory nature of the fish. This has taught us an important lesson, viz. that species is to be avoided inspite of it, being a more or less prized fish for the table. It is not only very voracious and predatory, but also a cannibal so the less we see of it in breeding tanks the better. In this we have lately received confirmation in a pamphlet issued by the Zoological Department of India.'[4]

Bombay : Unfortunately, information regarding fish culture in India has not yet been collated and codified and in consequence Dr S. B. Setna conducted further experiments on the culture of *murrel* in the Bombay Presidency. However, he did not take long to find out that this fish is not suitable for culture in tanks. In the Annual Report of his Department for 1938-39 it is stated :

'Fingerlings about 2 in. to 3 in. in length of this fish were collected from the Moola-Mutha river in Poona in May 1938, and 295 fingerlings were liberated in a pond at Vile-Parle on June 2, 1938. When the pond was fished on April 14, 1939, 42 *murrels* were obtained and it was found that the rate of growth had been phenomenal, the fish having grown within ten months from a size of 3 in. to 19 in. This amazingly rapid

[1] Anon—*Report of the Committee of Fisheries in Madras*, Madras, 1929.

[2] *Report of the Department of Fisheries*, Punjab, 1925-26.

[3] *Report of the Department of Fisheries*, Punjab, 1926-27.

[4] *Report of the Department of Fisheries*, Punjab, 1927-28.

growth encourages the hopes that it might be possible to introduce and breed *murrels* on an extensive scale in the fresh water fisheries in this province. Before any attempt on an ambitious scale is, however, made to introduce fingerlings of *murrel* elsewhere in the province it will be necessary to determine how far Moola-Mutha river will be able to provide the required supply of fry. The amount fetched by the sale of fattened *murrels* from the Vile-Parle tanks was Rs. 10.'[1]

In the next Annual Report (1939-40) the opinion is changed, for it is stated :

'The growth of *murrel* was not on the same satisfactory scale as recorded in last year's report. Two hundred and fifty *murrel* fingerlings obtained from the rivers near Poona in May 1939 were introduced in the same tank as was used for stocking *murrel* in the previous year, in July 1939. The pond was dragged after 7 months in February 1940. Their growth was scanty and their size diminutive. The only explanation of this unsatisfactory growth is that no *Megalops* fingerlings were introduced together with the murrel as in the previous year, when the *Megalops* must undoubtedly have served as food for the *murrels*. The observation shows that the successful and paying cultivation of *murrel* depends largely on natural live food, as has been conclusively established by the investigations of the Madras Fisheries Department. The hopes expressed last year of a bright future for the cultivation of *murrel* were unfortunately not realized during the year.'[2]

Conclusions drawn

The results of the experiments conducted in Madras, Punjab and Bombay make it abundantly clear that under ordinary circumstances the *murrel* is not a suitable fish for culture in ponds and tanks, but marshy areas, unsuitable for the culture of *rohee*, *catla* etc. could be used for the fattening of the *murrel* on account of the abundance of natural live food in them. If it be intended to culture *murrel* in tanks, arrangement must be made before hand to provide it with sufficient live food in the form of frogs, minnows, insects, etc. so that it finds no excuse to turn into a cannibal and devour its young ones. In this connection, attention may be invited to the culture in the southern regions of the United States of the bluegill sunfish (or bream) and of the carnivorous fish, largemouth black bass, in the same pond :

'The bluegill sunfish (or bream) is the perfect pond forage fish for the southern states. It multiplies fast, and is good to eat. A fertilized pond will support a large number of adult sunfish weighing around half a pound, an ideal size for frying. From one pond I caught 15 in 30 minutes—about as fast as I could bait the hook.

'A new pond, after fertilizing, is stocked with exactly 1,500 sunfish fingerlings per acre. During the first year each pair of sunfish will produce about 4,000 young. Unless these new fish were held down in numbers, there would be, within a year, 3,000,000 little sunfish per acre. Here the carnivorous fish enters to complete a stable food chain. The choice for the southern regions is the largemouth black bass, a hardy, fighting fish. For every 1,500 sunfish, 100 bass fingerlings are stocked. Fewer bass may fail to keep the sunfish population within bounds ; more may annihilate it entirely.'

'One year after stocking, a pond is usually supporting the maximum weight of fish for the available food, which means in a well-fertilized pond as much as 500 to 600 lb of fish per acre. Of this total weight, between 150 to 200 lb. per acre will be bass—three to four times as many bass as the best natural lake you ever fished.'[3]

Unless a similar association of *murrel* and of another rapidly multiplying fish is established for Indian waters, it will be, in my opinion, a waste of time to culture *murrel* in ordinary tanks. It may be noted in this connection that the Chinese, the ancient and the best farmers of the world, are not culturing this fish for reasons indicated above.

[1] *Annual report of the Department of Industries, Fisheries Section, Bombay*, 1938-1939.

[2] *Annual report of the Department of Industries, Fisheries Section*, Bombay, 1939-1940.

[3] *Reader's Digest*, February 1945, p. 84.

THE PROBLEM OF ESTIMATING THE SURPLUS OF A LIVE-STOCK CROP

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WITH the phenomenal increase in the demand for meat and the difficulties of adequately supplementing the indigenous supplies through import, India faces yet another war-time problem, viz. how best to take full advantage of the existing meat resources of the country, without unduly depleting the live-stock population.

Live-stock disposal policy

It is realized that the animals required for meat would form a fairly large number and any policy of live-stock disposal decided upon now, is bound to be reflected in the live-stock and agricultural economy of the country as a whole, in post-war years. It is of prime importance then, to shape our live-stock disposal policy now, in such a way, that no denuding of basic live-stock population (by which is meant the minimum number needed to keep the agricultural economy in equilibrium) would occur in post-war years.

Ideal aimed at

The Government of India along with provincial and state Governments have shown full awareness of the gravity of the live-stock position and have instituted prompt measures to bring it under control by restricting export and fixing minimum ages for slaughter. These measures in themselves should go to ease the live-stock situation in the country to some extent by ensuring conservation of the young and breeding stock the nucleus round which centres future population growth. It is, however, feared that the ideal aimed at may not be fully realized in practice and that a certain percentage of basic productive animals are likely to be slaughtered along with really unproductive ones. Our aim is to see that the former are kept down, as far as possible, to a reasonably low level ; which can be done by determining in advance estimates of different kinds of live-stock that can safely be slaughtered in a given area, in a given interval of time, and further taking precautions to see that these do not include the young and basic productive stock.

Live-stock estimates

It is understood that certain provincial governments are preparing with the help of their respective veterinary and animal husbandry departments, estimates of animals available for disposal at the end of a given interval of time. The purpose behind these estimates is to check indiscriminate slaughter and provide a safe basis for a sound disposal of live-stock. There are certain drawbacks in all estimates of this type that purport to predict in advance probable surpluses on the basis of certain assumptions that may not be strictly true or valid. The purpose of this article is to clearly bring out what these assumptions are, so that due notice may be taken of them and suitable allowances made in working out live-stock surpluses.

Live-stock surpluses

Surplus is only obtained when it is intended to keep a growing population 'static' in numbers or at a constant level. It is important, therefore, to decide first what these static population levels are for given areas. This can be done by the live-stock officers concerned who are in full possession of all relevant information on the subject. Surplus is that number which exceeds the static population number, after taking into account the mortality rates both in new borns and original animals in the population. In practice, surplus refers to only the adults in the population. It has to be emphasized that an estimated surplus would occur only at the end of the interval of time for which it is calculated.

As the surplus is caused through reproduction, it is further essential that the interval for which the surplus is being estimated be so fixed that it covers (1) the breeding season, when present and (2) the average time taken for producing young.

To be on the safer side the interval can be suitably adjusted to include the average interval between time of delivery and next fertile service.

Determination of population growth

Exact formula for determining increase or decrease in population numbers at the end of a given interval is known and is applied to human

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SELECTION, PREPARATION AND MANAGEMENT OF FISH NURSERIES

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FOR the success of any scheme of rural pisciculture, it is of paramount importance to ensure a regular supply of fish-seed for cultural operations. As the Indian carp, unlike the European carp, do not breed in ordinary tanks, the question of fish-seed supply in India presents certain difficulties. The trade has, however, solved this problem, so far as Bengal is concerned, by collecting spawn from rivers and bundh-type of tanks and raising it to the fry stage by keeping it in specially prepared nurseries.

Procuring and stocking fry

Only in the case of bundh-type of tanks, are eggs collected and hatched in hatcheries before transferring them to nurseries. Where the spawning grounds of fish have not yet been located there is a universal practice of obtaining fry from the rivers, flooded fields and channels and drying up pools and transferring them to stocking tanks for cultural purposes. This is an expensive and undependable process, both in the matter of procurement and transport of fry, but it has the advantage that selected fry can be stocked and once stocked their mortality rate is low. If, on the other hand, spawn be available, the same results can be achieved by keeping the larval forms in nurseries and raising them to the desired size through fertilization of the pond. The advantage of setting up regular nurseries is that large stocks can be raised in close proximity to the areas selected for fish farming thus eliminating excessive cost of fry and transport and ensuring the availability of stock when required.

To step up fish production, most countries induce fish farmers to cultivate their ponds by giving them fry free or at a subsidized rate. Such a proposal, if made for any part of India, would necessarily mean the maintenance of large stocks of fry for distribution purposes. This could only be possible by establishing Government fish-seed farms. It must, however, be borne in mind that the younger the fry the easier it is to transport it in bulk. Raising it to the desired size later can be achieved through the practices described below.

Fish seed-farms or nurseries

The larval forms and young fry require shallow warm water full of microscopic organisms on which they feed. It is, therefore, evident that shallow tanks, which dry up for a part of the year, are most suitable for setting up nurseries. The bottom of such ponds, when dry, should be ploughed, heavily manured and, if possible, a short leguminous crop be raised on it for green manuring. One great advantage of such a tank is that all predatory fishes, such as *sol*, *saul*, *lata*, *chital*, *phaloi*, *boal*, etc. can be removed. Its embankments should be so mended that voracious fish do not find access to it.

Manuring nurseries

The common and cheap manures to be used in nursery tanks per *bigha* area are cowdung, two baskets; stable refuse and poultry manure, two baskets; oil-cakes, ten seers; green grass bundles, two mds.; etc. As each pond has an individuality, it is difficult to suggest a standard quantity of material applicable to all cases. It is desirable, therefore, that the material suggested here should be applied gradually so as to avoid too much harmful pollution.

After fertilizing, the water takes a delicate sea-green opalescence from the myriads of plankton and later the growth of organic matter should be so maintained that it should become impossible to see more than 10 inches below the surface. 'If the farmer can see his hand a foot or more down, it is time to add more fertilizer. No other test is needed. The plankton by the way prevents the fish from seeing the fisherman or his boat'. Chemical manures, such as ammonium sulphate, saltpetre, ammonium superphosphate, etc. can be used with great advantage. If sewage or washings from a cattle farm could be drained into the pond, the result will be good but careful watch must be kept that there is no pollution. It will be advantageous at this stage to introduce some *chala* fish in the nursery to feed on excess growth of plankton. They will fatten quickly and should be removed after 10 to 15 days, and after that spawn should be introduced. When the fish are growing, it will

be better to net the pond occasionally after 12 to 15 days of the liberation of the spawn without actually taking out the fish. It will help to dissolve the manures and give exercise to the young fish.

Eradication of predatory fishes

It is not absolutely essential that a nursery pond must naturally dry up for a part of the year. A shallow pond from which all predatory fishes can be excluded will do just as well. After thorough netting and proper manuring, it should be allowed to settle and then the spawn introduced in it. The eradication of predatory fishes may present a difficult problem and, therefore, it is advisable that the water be baled out or drained and the bed exposed to the sun's rays so as to make sure that all voracious fish have been exterminated. Wherever possible or practicable a fine-meshed wire netting about a foot or so high should be placed round the tank to prevent predatory animals getting access into it. Ducks should not be allowed on such tanks as they are destructive to fish spawn. A nursery pond one *bigha* in area (one acre= three *bighas*) and 4 to 5 ft. deep can be used for rearing one *kunka* of spawn containing approximately one lakh larval forms provided proper manuring is done and attention is paid to the health and welfare of the young. If at any time the water-level in a nursery tank falls below 2 ft. in depth and water has to be added to it from an outside source, care must be taken to prevent the introduction of predatory animals by placing wire-netting of a suitable mesh in the passage of the inflowing water.

Watch baby fish in nurseries

The nursery tanks should be carefully watched from the time the spawn is put in. If everything goes well, the young fish will come up to the surface regularly every morning at an early hour and continue swimming just below the surface till 8 to 9 a.m. when they should go down. This they do in order to warm themselves after the chill of the night, and hunt for their breakfast animalcules. If they do not go down after the sun is well up, it must be presumed that there is some mischief, i.e. there is either an enemy at the bottom, or there is not sufficient food for all of them in the water, or there has been a transformation in the character of the water which they do not like. The remedy in such a case is to drag a net in the tank at once and ascertain first of all whether there is any predaceous fish or other enemy below. If so, the fry would be all right after the removal of the enemy. If no enemy is discovered, then some of the fish should be removed to another tank to relieve the over-crowding, and, if even this does not prove efficacious, it must be presumed that the water is not suitable for the growth of fry and the remaining fish should be removed to another tank. It is generally found sufficient to drag the tank several times as thoroughly as possible to alter the character of the water for the benefit of the fry.

Raising fry in nursery ponds

Fry of a size not exceeding an inch can be grown in nursery ponds referred to above; but to obtain better results, it will be necessary to transfer them into larger nursery tanks so as to grow them to 3 to 6 inches in size before planting them finally into rearing tanks. In the larger nursery tanks a *bigha* of space should be sufficient for about 50,000 to 1,00,000 fry according to the food store in the pond, but with the growth of fishes, their space and food requirements also increase, so a correspondingly larger area should be provided for them. Repeated transplantation of fishes from pond to pond leads to better and healthy growth, provided fishes are carefully handled at the time of transfer.

Construction of Dams and River Fisheries

by

Sunder Lal Hora, D.Sc. (Punj. et Enin.), F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I.,

Zoological Survey of India

INTRODUCTION

THERE is a great movement in India at present for the construction of multipurposes dams across several of our main rivers, the three principal objects being (i) Flood Control, (ii) Irrigation, and (iii) Hydro-electric power. No one disputes that India can be saved from lot of misery and poverty, from which it annually suffers by the flooding of some of its more turbulent rivers. For raising a much larger quantity of food grains for its rapidly increasing population, everyone will admit that vast arid areas lying fallow at present must be brought under cultivation through irrigation projects. Industralisation of India is also urgently needed and owing to the limited coal resources of the country, it is absolutely essential that hydro-electric projects on a vast scale should be undertaken in the country. While all this has been fully realised by the authorities dealing with post-war planning in India, it has been lost sight of that these very rivers form the most valuable fisheries resources of the country which should be given equivalent consideration to that given to all other water uses. It has long been realised in Europe, America, Japan and other advanced countries that before obstructing any waterway containing commercially important fishes, surveys of the fisheries resources should be made by qualified experts, to parallel engineering surveys, over a minimum period of five years, or sufficient to cover the life-cycles of all economically important fishes concerned. It should always be borne in mind that the development of fisneries in India has a special role to play in the balanced nutrition of the Indian people. In this connection reference is invited to the following recommendation made by the Famine Inquiry Commission (1) :—

> "*In India, where the* per capita *intake of meat and milk is small, fish has special importance as a supplement to ill-balanced cereal diets. The present supply of fish is totally inadequate ; the development of fisheries is one of the most promising means of improving the diet of the people.*"

For our guidance concerning the construction of dams and of safeguarding against any possible deterioration of river fisheries, the following quotation from Veblen (*The Instinct of Workmanship*) seems very appropriate :—

> "*Virtually all thoughtful persons will agree that it is a despicably inhuman thing for the current generation wilfully to make the way of life harder for the next generation, whether through neglect of due provision for their subsistence and proper training or through wasting their heritage of resources and opportunity by improvident greed or indolence.*"

River fisheries are a great heritage from the past and, in the interest of the future generations, should be judiciously exploited with due regard to conservation, if not augmentation, of existing resources. In India, where carp do not breed in ordinary tanks, fish-seed for cultural operations are obtained from rivers annually and this ultimately leads to the production of several *lakh* maunds*† of fish from tanks distributed all over the country. In their lower and middle reaches, the rivers provide a passage for migratory fishes, either from the seas or estuaries or from one part of the river to another, to reach their spawning grounds. In their higher reaches, they are reservoirs of our principal game fishes, such as Mahseer, Indian Trout, *etc.*, which also migrate into shallow waters for breeding purposes. Thus any obstruction to the passage of a migratory fish up a river would constitute a great menace to the continuance of its fishery and in most of the civilised countries any obstruction is illegal unless an adequate provision is made in the structure for the passage of the fish.

PRESENT POSITION IN INDIA

Besides the construction of a large number of new dams that are under contemplation, several exist already and it is a matter of deep regret that none of the existing dams possesses an *effective* "fish pass". Dr. Francis Day

(1) Famine Enquiry Commission, Final Report, 1945, page 220.

*100,00.

in the sixties of the last century found that the construction of anicuts across the rivers of Madras had resulted in the deteriorat on of their respective fisheries and quite recently Dr. D. W. Devanesen has shown(2) that the *Hilsa* fishery in particular has deteriorated still further in the Godaveri, the Kistna and the Cauvery. In the Punjab, Dr. Hamid Khan has shown(3) that

> "*The effect of inefficient fish ladders in the Punjab is beginning to be felt in the higher reaches of the rivers and there seems to be no doubt that as a result of it the stock of fish in the Punjab rivers has decreased very considerably during the last fifteen or twenty years.*"

Seeing that this natural source of food of very high biological value was being ruined before our very eyes through lack of foresight and technical knowledge of the problems involved, the writer raised the question of fish passes at the meeting of the Fish Committee of the Imperial Council of Agricultural Research in October 1941. On the recommendat'on of the Committee, the Governing Body of the Council requested

> "*all provinces and State Governments to give due consideration to the fishery resources of the waterways, and that before starting construction of a dam or other types of structure proposed in any basin containing migratory fishes, surveys of fishery resources should be carried out by an expert with a view to making proposals to safeguard the interest of the majority of economically important fishes of the area. It was further recommended that as fish-ladders in some provinces had proved to be unsatisfactory, they should be replaced by more suitable devices to safeguard fish populations. Similar measures should also be introduced in other provinces where they did not already exist. It was also suggested that fishing should be prohibited within one mile of the lower reaches of a dam.*"

It is extremely unfortunate that the authorities concerned with the planning of dams and weirs have paid no attention to the very sound and practical recommendations of the Imperial Council of Agricultural Research. The Council, however, realising the great national importance of riverine fisheries consulted the Central Board of Irrigation with regard to the standardization of fish passes and in consultation with this body decided that before the engineers could plan a standard fish pass, the fishery biologists must supply them with detailed information regarding the bionomics, particularly pertaining to movements (capacity for leaping and swimming against a swift current), life-histories and varieties of fish to be dealt with in the various river basins of India. The Council, therefore, sanctioned a small scheme which came into operation from the 1st May, 1946. Even at a very early stage of these investigations, it became clear that an experimental "Fish Pass" was a necessity and the Council very kindly accepted the proposal and provided funds for its construction. Such an experimental fish pass is now under construction at Galsi, the seat of the River Research Institute, Bengal, under the kind supervision and direction of Dr. N. K. Bose, its Director. The fish pass will have an adjustable slope so that movements of fish through different velocities can be determined. Unfortunately, the official red-tapism caused delay and the pass could not be got ready until after the monsoon when the migratory instinct among fishes, particularly for breeding, is well pronounced. However, the records kept throughout the year will be of value in elucidating the behaviour of fish during seasons.

POSSIBLE LINES OF RESEARCH ON FISH-WAYS

After drawing up a programme of fish survey above and below the Anderson Weir; the records of data collected from the fishermen regarding the migration of various fish before and after the construction of the Weir, and data obtained through direct observation of the movements of *Hilsa* during the monsoon, I left for the United Kingdom to attend the meetings of the Royal Society Empire Scientific Conference and the British Commonwealth Official Scientific Conference in June-July. Fortunately, at one of the aerodromes Professor M. N. Saha directed my attention to an article(4) by Dr. Maurice Burton, entitled "Speed in Water". On arrival in London, I obtained a copy of the paper and directed attention of the Technical Assistant under the Scheme to this article, since it had a direct

(2) Current Science, XI, 1942, page 398.
(2) Bombay Natural Historical Society, XLI, page 551, 1940.
London news of May 25, 1946, page 572.

bearing on the problem we had set out to investigate with regard to the bionomics of Indian fishes. He in reply wanted me to purchase for him a "fish-o-meter" and to consult some literature for him in the British Museum (Natural History) which was not available to him in India. With regard to "fish-o-meter", I made enquiries from Professor J. Gray, F.R.S., of the Cambridge University, whose classic work on the movements of fishes and other animals is well known. At the same time, I explained to him my problem in India. He very kindly sent me the following reply in his letter, dated the 8th July 1946 :

"I suspect that a 'fish-o-meter' is an instrument (invented many years ago by a Frenchman) for measuring the rate at which a fish can run out a line when the tension of the line is known. If this is so, I do not think you will be able to buy one ready made in this country, although it could not be difficult to have one made to one's own design. From a practical standpoint there are, however, various difficulties attached to its use, and still further trouble in applying the results to the practical problem of finding out the maximum current at which a fish moves in nature. The conditions of water flow in a natural river are so complex that it is impossible to design laboratory experiments which give any real guide to fish pass construction. The Belgian engineer Denil published some interesting observations and the Inst. of Civil Engineers did some work on similar lines a few years ago. I can give you these references if you would care to have them, but I think you will find that the design of fish passes is essentially empirical and not based on any accurate knowledge of the power output of the fish. Pryce-Tannant (at the Ministry of Fisheries) is the expert on fish pass design for Salmon in this country."

Pryce-Tannatt's "Fish Passes" (Edward Arnold & Co., London, 1938) is a publication well known to irrigation engineers even in this country. In the preface to this work, Pryce-Tannatt has stated :

"The designing of a fish pass is fraught with uncertainty, because it is almost impossible to prophesy the behaviour of fish and quite impossible to anticipate the vagaries of water. The subject involves a working knowledge of hydraulics ; and, while hydraulic engineers conversant with the habits and requirements of fish are rarely to be found, the rules and assumptions of hydraulics themselves are apt to be disconcertingly upset when applied to the functioning of a fish pass. The subject is by no means within sight of finality. There is indeed much about it yet to be learnt and unlearnt."

On the termination of the Conference, I went to consult literature in the British Museum (Nat. Hist.), where Dr. E. Trewavas, at my request, had kindly taken out some works, particularly the contributions of the Belgian engineer Denil, on the subject of fish movements. The more and more I read of the literature on Fishways, the less and less competent I felt of guiding research on this very important aspect of the future economic life of India. I arranged a meeting with Professor Gray and went to Cambridge to discuss in detail the programme of work that could be done in India. We had a very interesting and fruitful discussion and subsequently in his letter of July 23, 1946, Prof. Gray wrote to me as follows :—

"I was very much interested in our recent conversation concerning the possibility of conserving the river fisheries of India by taking advantage of recent work on the mechanics of fish movement and design of fish passes.

"As I explained to you, the whole problem should be tackled at once, and every endeavour made to take advantage of recent research. I am quite clear that the first step should be the construction of a number of relatively straight channels down which water flows at a known velocity. These channels could be used as direct test for velocity of current, up which fish of known species, sex, etc., can swim. Observations of this type would be a most valuable guide to subsequent and more carefully controlled work which might involve more complicated apparatus.

One of the difficulties in connection with work of this type is the way in which purely biological problems begin to involve quite a high standard of physical and hydrodynamical knowledge. Work on these lines has been going on in my department for some years, and we should be extremely pleased if you cared to make use of our experience in connection with very important practical problems.

which arise in India. I would suggest that if you have a student or official, who will be in charge of the preliminary work on the water channels mentioned above, he might well come here for a few months during the off season. We could then see that he has first hand experience of the type of work being done here, and he could see the types of fish passes which are being constructed in this country. It would, I think, be useful if, for example, he could familiarise himself with the Houssay-Magnan apparatus for determining the speed at which particular fish can swim against a known resistance. We could probably arrange for one of these instruments to be built in the workshop here, if necessary.

" *I was extremely glad to have the opportunity of hearing about your problems in India and, as I have said before, I shall be only too delighted to give you any assistance I can either personally or by means of this department.*"

Professor Gray's most helpful and practical suggestions were conveyed to the Secretary, Imperial Council of Agricultural Research, and a request was made that the Technical Assistant under the Scheme, who will have gained some knowledge and experience of the problem should be permitted to go to Cambridge and work under Professor Gray's guidance and supervision. The matter was considered by the Fish Committee and unfortunately the proposal was not accepted.

It was fortunate that at one of the Official Dinners in London, Mr. J. E. de Watteville, Secretary, Fisheries Division, Scottish Home Department, was seated next to me. In the course of our talk, he informed me that considerable amount of research and experimentation is being carried on in Scotland for the standardization of Salmon and Trout passes to be constructed in hydro-electric dams. I requested him to put me in touch with the workers. Through his kindness, I received the following extremely useful communication, dated the 22nd July, 1946, from Mr. P. R. C. Macfarlane of the Fisheries Division :

" *Mr. de Watteville has told me of your meeting with him in London last week and of your interest in fish-pass*

" *Over the pass twenty years or so, we have had considerable experience of problems connected with passage of salmon at hydro-elecric power development dams of various heights, upto 74 feet. Our passes are all of the pool-to-pool type. In some cases the connection between adjacent pools takes the form of a submerged orifice ; in others, the over-fall weir is employed. Where the submerged orifice is used, we consider that the step between pools should not exceed 2 ft. for the over-fall weir, it should be limited to 18-in. or less. The most important part of any fishway is the lower entrance, which should be so sited as to provide the greatest attraction and the easiest access to fish arriving at the obstruction. Where passes are required to be of considerable length, enlarged resting pools should be incorporated at intervals.*

" *We have two fishways of rather unusual construction. In these the pools rise spirally inside a concrete tower standing within the reservoir. To allow for the varying level of the reservoir, each of the upper pools is provided with a sluice-controlled orifice giving direct access to the reservoir—a provision electric dams, when necessary. The lower end of each of these fishways runs through a tunnel at the base of the dam to the pool where the fish congregate on the downstream side. These passes work well in practice, and the design is suitable where conditions are such as to make the more normal method of construction impracticable or unduly difficult.*

" *If you have not already got a copy, I think you would find it most useful to have the 'Report of the Committee on Fish-Passes', issued by the Institute of Civil Engineers in 1942 and published by William Clowes & Sons, Ltd., Axtell House, Warwick Street, Regent Street, London, W.1. This research was carried out under the direction of Professor C. M. White, Imperial College, South Kensington, and I am sure you would find it particularly helpful if you could arrange to have a talk with him on the subject.*

" *I would also suggest that you might care to get in touch direct with Dr. John Berry, North of Scotland Hydro-Electric Board, 16 Rothesay Terrace, Edinburgh, who is concerned in research in connection with modern fish-pass design on behalf of the Board. I*

have spoken to Dr. Berry about your interest in the subject and he would be very glad to hear from you.

"If there are any specific points of detail on which I could be of assistance to you, please let me know."

After the Conferences, the time at my disposal was so short and arrangements had been previously made to visit certain centres of fisheries research that I could not arrange to meet Professor C. M. White in London and thus missed a valuable opportunity to gain knowledge about the problem. However, I wrote a letter to Dr. John Berry, who in his letter of the 2nd August, 1946, *inter alia* stated :—

"*As Mr. Macfarlane will have told you, I have been personally interested for many years in the design of fish passes, and indeed in all aspects of freshwater fishery development. But so far as the activities of this Board are concerned, no new passes have yet been constructed, although we* are pressing on with research and design. *The Board have to safeguard the valuable salmon and trout fisheries throughout the north of Scotland in which they are now responsible for the erection of a very large number of hydro-electric dams, aqueducts and other works.* The problem of fish pass design is therefore one of importance to us."

Dr. Berry very kindly sent some drawings of an experimental pass in connection with which further tests have yet to be carried out shortly on a larger scale. He also suggested to Messrs. Glenfield and Kennedy of Kilmarnock to send to me a blue print of a new fish lock, a model of which was demonstrated by them recently in the United Kingdom.

The readiness with which experts were willing to help and supply information in their possession was my most pleasant experience in the United Kingdom. It was extremely unfortunate that I had no time to pursue the subject further and to inspect the various constructions. However, the following facts have become impressed on my mind which have some significance for the prevailing apathy towards fish passes in India :—

(i) Since the sixties of the nineteenth century, there have not only been legal restrictions, but effective checks, on the erection of obstructions in salmon and trout rivers in the United Kingdom.

(ii) Owing to the legal restrictions referred to under (i), it became incumbent on waterways engineers to carry out research regarding the designs of the most suitable and cheap fishways.

(iii) For a small country, like the United Kingdom, with only a few small rivers what an amount of research is being conducted on the improvement of old fishways or the designing of new types.

(iv) Considerable amount of research precedes the construction of a dam and research on fishways is regarded as essential as other surveys, engineering, geological, *etc.*

RESEARCH FACILITIES IN INDIA

In the absence of any legislation in India against the obstruction of passage of migratory fishes, the irrigation and hydro-electric engineers have not troubled to pay any attention to the fishery resources of the rivers or to the movements therein of economically important fishes, with the result that even where the fish passes exist they merely serve as traps and not effective passages for the migration of fish. From enquiries made from a number of irrigation engineers in India, it has been ascertained that there is not a single engineer who has specialised in the designing and construction of fish passes under Indian conditions. The information supplied in Vol. 3, No. 3 of *The Central Board of Irrigation Journal* (July 1946, pp. 159—168) regarding the researches being conducted at the various irrigation Research Institutes painfully reveals that nowhere research on fish-passes is conducted, though for the conservation of India's extensive riverine fisheries free movements of migratory fishes is of the utmost importance. It would, therefore, seem of considerable national importance that some suitable irrigation engineers and fishery biologists with considerable local experience should at once be sent abroad to study the problems presented by the construction of dams and the measures that should be adopted to overcome them. It is time that some Research Institutes should take up active research on fish passes. Till we are ready to safeguard the fishery interests of a river, it

will be a national calamity in the long run to obstruct the passage of economically important migratory fishes.

In this article, I have dealt with the subject of dams and fisheries in a general way, but in the next article I shall deal specifically with The Tista Project, of which an account is published in the July 1946 issue of the *Central Board of Irrigation Journal.*

ACKNOWLEDGEMENTS.

I have indicated in the text throughout the ces from which I have received help and information regarding the problem of fish passes. I wish to record here my sincerest thanks to Dr. N. K. Bose, Professor M. N. Saha, Professor J. Gray, Dr. E. Trewavas, Mr. J. E. de Watteville, Mr. P. R. C. Macfarlane and Dr. John Berry. I have taken the liberty of quoting from some letters long extracts, for they contain extremely valuable new information from specialists actively engaged in research on fish movements or the designing and construction of fish passes.

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FOOD CRISIS AND FISHERIES*

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to the prevailing food situation in the country, it is heartening that Mahatma Gandhi has directed attention to the fact that fisheries constitute a basic food industry. In times of emergency like the present, it is imperative that this source of food should be utilized to supplement the deficiencies and failures of crops and foods from the land. When, owing to malnutrition, resistance to diseases is diminishing, emphasis must also be laid on the fact that most of the aquatic foods are almost a perfect balance of the important nutritional factors, such as proteins, vitamins and minerals. There are cases on record that during famines in the past in certain parts of India thousands of lives were saved by the addition of fish as an article of normal diet.

Thomas in his famous work "Rod in India", published in 1881 made a special reference to the role of fisheries in the famine of 1877 and pleaded for the development of riverine and marine fisheries. Again, Edye in his "Report on the Fisheries of the United Provinces" published in 1923 stated: "In the scarcity of 1919 at the Bijainagar reservoir near Mahoba I saw a village community turn out and catch without difficulty enough big *Rohu* to give every man and his family an ample and much needed meal." He then expressed the opinion that "A plentiful supply of *Rohu* (with *Naini* and *Catla*) in these reservoirs will form a valuable food reserve in times of scarcity and famine. At these times food becomes very scarce in May and June, when owing to the monsoon failure, which has caused the famine, the reservoirs are mostly reduced to a few small

* Adapted fom a talk given at the Rotary Club, Calcutta, on 26-3-46.

pools, and the fish are easily netted out". It is a common practice with the people of the Khulna District to go out fishing in the Sunderbans in times of scarcity and famine and thereby supplement their meagre produce from the lands. It is thus clear that in India fish has served as a stand by in times of scarcity and famine in the past, though organized attempts such as are now suggested by Mahatma Gandhi, have not hitherto been made either by the Governments or the peoples in India.

Mahatma Gandhi has now suggested, in his letter of the 21st February 1946 to the Viceroy that "Fish abounds in the seas around the coast of India. The war is over, there are innumerable small and medium-sized vessels which were used for doing patrol and guard duties along our shores for the last five years. The R.I.N. could arrange about staffing these, with the Department of Fisheries giving all assistance. If everything and anything can be done during a war why not peace time war effort? Dry fish does not even form part of the normal diet of a great number of people who are very poor—that is when it is available and they can afford to buy it."

Mr Abell in his reply of 26th February 1946 on behalf of the Viceroy stated, "Only a day or two ago His Excellency suggested to the Commander-in-Chief that it might be possible for the R. I. N. to assist with fishing. Recent events may make this difficult, but meanwhile His Excellency has initiated enquiries about the possibility of importing dried fish from Canada and Newfoundland, and also about the securing of suitable vessels and equipment so as to make a start with developing on modern lines the fisheries industry."

Since the publication of this correspondence on the 8th March 1946, the writer has received several enquiries and comments from his friends who are interested in the development of fisheries on an all-India basis. In times of scarcity and famine, fisheries have a much greater role to play in Bengal than any-

where else in India, since over 90 per cent of Bengal's population would eat fish if they could get it.

It was on the 30th January 1946 that the Government of India, through its statement in the Legislative Assembly, brought to the notice of the general public the critical food situation in the country. The very next day the officers of the Directorate of Fisheries, Bengal, resident in Calcutta, met to discuss the best means to increase the food supply from various types of fisheries in the province on an emergency basis. There is no doubt that assistance from the R.I.N. would be of considerable value to fish production.

This aspect has also been under consideration of the Directorate of Fisheries long before Mahatma Gandhi sent his suggestions to H. E. the Viceroy. The writer differed from Mahatma Gandhi in one respect and that is that it is unlikely that the R.I.N., even if they would, could help very much in actually catching fish from the sea, as the R.I.N. personnel are not fishermen by trade and it is doubtful whether they have the necessary equipment. They could, however, be of considerable value in other directions, such as assisting with transportation, towage and surveys, etc., provided, of course, that the exigencies of the service would permit such a course of action. In times of dire necessity and in view of the absence of any fishing gear, perhaps depth charges could be used to blow up fishes from among shoals when located.

There is a great urge from the educated and modernized Indian people to get trawlers from Europe or America and thereby make the fish cheap and abundant in the Indian markets. Such enthusiasts do not realize that trawling grounds must first be charted, expensive boat and nets purchased and trained personnel recruited before trawling can be undertaken. Besides, trawling is a capitalistic undertaking and has little bearing on the rural economy of India.

No doubt the background of this belief is the successful trawling industry of Great Britain. But compare the geographical and social features of India with those of Great Britain. Great Britain is an island. There is no town in the U. K. which is more than 70 miles distant from the sea. There are no large rivers, the number of village ponds is negligible, the climate is temperate, the population is literate, the general standard of living is high and the means of communication are good. There is no wonder, therefore, that an Englishman is brought up to look upon development of fisheries only in terms of marine fisheries, particularly trawling in the North Sea. Unfortunately this psychology has been responsible for the neglect of inland fisheries in India. It is often overlooked that India is a sub-continent and India's millions live far away from the sea, India has vast inland fishery resources, the climate is tropical, the people are illiterate and ignorant, the general standard of living is low and the means of communication are extremely poor.

Since his appointment as Director of Fisheries, Bengal, in May, 1942, the writer has been advising private interests that European methods of fishing, particularly heavy trawling, are not suitable to Indian conditions and the same view have recently been expressed by Dr L. F. de Beaufort, and Dr Albert W. C. T. Herre, the two great authorities on the fish and fisheries of the Indo-Australian Archipelago. In a symposium on the "Development of Indian Fisheries", Dr de Beaufort replied from Amsterdam in his letter of March 8 as follows:

"I wish it were possible to fly over to India and meet my friends, but that is quite impossible.

"I neither see my way in sending you a short summary but I can give a few principles as suggestions. When fishing in New Guinea with an Indonesian Collector, he used to say, 'Indian fishes have to be caught with Indian methods' ". My first principle is therefore:

1. *Do not try European methods.*

The experiments made with North Sea trawler in the Java Sea have not been successful. Since the Japanese started fishery in the Indo-Australian Archipelago about 20 years ago, the fish markets in Java were over-flooded with a quantity of species, which thereto were never brought to market. Hence :

2. *A study of the Japanese fishery methods ought to be made.*

This is of course as far as marine fisheries go. I do not know if what is said above also holds good for India".

Of course, these principles apply as strongly to India as to Indonesia. Indian students will get much better training for developing the fishery of their country from China and Japan but such views received scanty attention. After studying the marine fisheries of Madras, early in January the writer told a press representative in Madras that so far as the development of marine fisheries was concerned, India would do better to ask for Japanese fishing vessels and personnel under the reparation terms and then we should train our own students on these vessels, for no amount of *technical knowledge* can be a substitute for *local experience* in developing the fishery of a country. In fact, this will apply with equal force to the exploitation of all other natural resources as well.

Estuarine fisheries in Bengal have been fairly successfully exploited with primitive boats and crafts. The general public have developed the taste for these fishes and there is a heavy demand for them. Their proper exploitation is intimately bound up with small power-driven carrying craft and a suitable system of refrigeration and marketing. So far as is known to the writer, Sunderbans estuaries are the only ones that are being exploited at present to any appreciable extent while all other Indian estuaries are awaiting development.

Among freshwater fisheries, the exploitation of rivers, lakes and *bheels* has to be correlated with their

productive capacity, natural recuperation, conservation, etc., and, therefore, they have to be very judiciously worked on a long-range plan in the interest of posterity, for if a fishery is depleted through over-fishing, it may take very long to replenish it to its original capacity. These fisheries are localized and have, therefore, to face the problems of refrigeration, transport and marketing as is the case with the marine and estuarine fisheries, though to a very small extent.

In the proper utilization of the village pond, ideal conditions are available for the feeding of the poor with a nutritive diet and for raising their standard of living; the two objectives which the Famine Inquiry Commission have suggested should be the Food Policy of the Government of India. As the idea aimed at is to make protective food available to every one, the problems of distribution, preservation and marking do not arise in the case of tank fisheries. If an excess quantity is caught on a particular day, it can be stored in the tank itself in live wells. There is very little chance of wastage.

It is greatly to be regretted that the fifteen-point food programme of the Congress Working Committee issued from Bombay on March 15 and designed to meet the present food crisis has overlooked the possibilities of pond fisheries altogether. The Committee would have done great service if they had included, under point two,* impounded water areas and low-lying lands which can be easily reclaimed, by digging a tank for fish culture and raising the surrounding areas with the earth obtained therefrom, for improving lands for agriculture. Such reclamation work is undertaken during the dry season and an appeal for such a development measure with aid from the State would have helped materially in food production.

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* The second point of the fifteen-point food programme of the Congress Working Committee is as follows :—

"(2) Every one who possesses any land should in the shortest time grow such foodstuffs on it as he can. Cultivable land lying waste should be speedily brought under the plough and every facility should be given for this purpose by the State".

It is encouraging that instructions have been issued for the employment of the Indian Army up to three days every week to assist in the all-out "Grow More Food" campaign now being launched. Particular attention is going to be paid for growing vegetables, potatoes, maize and wheat, and in suitable areas rice. Every encouragement is also going to be given within a unit for the production of eggs, poultry and rabbits. It is sincerely hoped that pond culture will also receive the attention of the Army, as vocational training already given to a number of Army personnel and a short three weeks' course is still being continued under the Directorate of Fisheries, Bengal. Pond culture is the easiest method of increasing the supply of protein food.

At present, an average village tank, is in an insanitary condition and almost neglected. It breeds mosquitoes and unless there is a monetary objective behind their improvement, no amount of sermons can do any good. Fish culture is the only remedy to improve them, for it presupposes suitable embankments, clearing of excess vegetation, drying up of the whole or of a part every year or occasionally, and maintaining it in a sanitary condition for the healthy growth of fishes. Thus, fish culture alone can impart to a village pond sufficient dignity. If it is further explained that the use of its water for irrigation to raise winter crops and the use of its banks and embankments for growing vegetables and fruits do not interfere with fish culture, its sanctity will become much greater . Milk is very scarce in India and increased production of milk depends not only on better breeds of cattle but to a very great extent on the availability of fodder. During the rains, there is a certain amount of green grass but in the dry months use of tank water to produce fodder crops can keep the cattle in a fit condition. If cattle are kept round tanks then the washings of the cattle-shed will be helpful to fertilize the tank water and encourage growth of fish. Duck rearing is another profitable cottage industry and the owner of

a tank, besides rearing fish in it, growing vegetables and fruits on its embankments and irrigating his land for double cropping, can use it for duck rearing with advantage to the fishery. Ducks will control excess vegetation, feed on insects, snails and bivalves and fertilize the water with their excreta of great manurial value.

The manifold benefits of pond culture and other food industries connected with the production of protective foods can be correlated with fish culture.

The Indian Army are now considering how best they can help in increasing the fish supply in scarcity areas, but it is possible that they can help in the following ways:—

(1) To provide personnel for clearing and cleaning tanks and for preparing them for scientific pisciculture.

(2) To provide personnel for digging new tanks and preparing them for pisciculture where this is required.

(3) To provide motor transport for carrying fish from fisheries to main fish markets and to transport fry and spawn.

(4) Through the Army Movement Control Organization to arrange for a general speed up in railway transportation of fish and for special fish trains to be run as and when required.

(5) To provide amphibious Ducks and amphibious Jeeps where these are required in large *jheels* so that fish can be collected from the fishing craft operating in these *jheels* and can be taken straight from the water to the market.

(6) To provide transport to take welfare goods, such as yarn, coaltar, etc., to inland fisheries.

Possibly the Royal Indian Air Force can also be of help in developing the fisheries of India by—

(1) Providing air transport for the carrying of fry and spawn.

Providing air transport for the carrying of fish from the fishing areas to the markets where other means of transport are slow or do not exist.

(3) Providing motor transport for carrying the fish from the landing ground or from the flying boat stations to the markets or to the railhead, whichever applies.

(4) Conducting an aerial survey for the location of shoals of pelagic fishes.

It may be stated in clear and forceful terms that for feeding the poor development of inland and marine fisheries is equally important under prevailing Indian conditions.

A rapid extension of freshwater carp culture is the most hopeful way of tackling the urgent problem of increased fish supplies.

In areas where fish production is well organized, fish technology should be immediately wedded to production so as to fully utilize the harvest.

Dried or smoked fish has a very limited scope in India as food, for India exports to Ceylon, Burma and Malaya large quantities of dried fish. Imports of dried fish from Canada and Newfoundland are not likely to achieve the objective in view.

It is encouraging that fisheries development has now received the earnest consideration of Mahatma Gandhi and that he has found some use for the science of zoology.

BRITISH COMMONWEALTH SCIENTIFIC CONFERENCES, JUNE-JULY 1946.

Prefatory Note.

The Indian Delegation to the Royal Society Empire Scientific Conference and to the British Commonwealth Scientific Official Conference held in the United Kingdom, June-July 1946, consisted of the following persons:—

1. Prof. H. J. Bhabha.
2. Sir S. S. Bhatnagar.
3. Sir J. C. Ghosh.
4. Dr. S. L. Hora.
5. Mian M. Afzal Hussain.
6. Sir K. S. Krishnan.
7. Dr. M. S. Krishnan.
8. Prof. P. C. Mahalanobis.
9. Dr. J. N. Mukherji.
10. Prof. M. N. Saha.
11. Prof. B. Sahni.
12. Prof. M. R. Siddiqi.
13. Col. Sir S. S. Sokhey.
14. Mr. D. N. Wadia.

Dr. B. C. Guha joined later after the departure of Sir S. S. Sokhey for the U.S.A.

Though the National Institute of Sciences of India was at no stage consulted with regard to the selection of the personnel of the Delegation by the Government of India, it so happened that with the exception of one, who has now rejoined the Institute, all others happened to be Fellows of the Institute. In London the idea was mooted that the Fellows of the Institute should be apprised of the impressions gained by each individual member of the Delegation by holding a Symposium at one of the General Meetings of the Institute. Accordingly, Mr. D. N. Wadia, our past President, invited the delegates in his letter of September 6, 1946, to give in brief general impressions and to mention such important papers, read or discussed, as have a bearing on Indian problems and also any papers contributed by the delegates either jointly or individually. The Symposium was arranged for the November 1946 meeting at Delhi, but as most of the delegates required more time, the Council of the Institute decided to hold the Symposium in April 1947 at Bangalore. As up to the last week of March 1947, Dr. Hora's was the only contribution, which had synthesised the proceedings of these Commonwealth Scientific Conferences and drawn conclusions that could form a useful subject for discussion, the Symposium was cancelled. At the Bangalore Meeting, however, the Chairman called upon Dr. Hora to communicate his contribution, which is now published by the express wish of the Fellows present at Bangalore and circulated to all Fellows, in the hope that other delegates and such other Fellows who have had opportunities to go abroad in recent years will be good enough to record their impressions bearing on Indian scientific and economic problems. If a sufficient number of contributions is received, a Symposium will be held at some future date. Members wishing to take part in the Symposium should communicate with the Secretaries at Delhi.

GENERAL IMPRESSIONS AND SPECIFIC CONTRIBUTIONS.

By Sunder Lal Hora, *D.Sc.*, *F.R.S.E.*, *F.N.I.*, *Director of Fisheries, Bengal.*

Contents.

INTRODUCTION.

The President of the National Institute in his letter of September 6, 1946, invited the delegates to the Royal Society Empire Scientific Conference to make a brief report of the work done at this Conference and its auxiliary meetings, as well as at the Commonwealth Official Scientific Conference. The President requested the delegates to give in brief general impressions and to mention such important papers, read or discussed, as have a bearing on Indian problems and also any papers contributed by the delegates either jointly or individually. The present contribution is in response to the above request and deals with such items only as are specified in the President's communication. Articles on several other subjects studied or discussed with corresponding scientific workers during this visit are being published separately elsewhere.

GENERAL IMPRESSIONS AND SUGGESTIONS BASED THEREON.

After listening to the accounts of the general scientific organisations and of scientific researches being conducted in the United Kingdom, Canada, Australia, South Africa, New Zealand and the Colonial Empire, it occurred to me that the following principles may prove of value in planning the development of scientific research in India:

1. Gradualness, not slowness, in Research and Development, except under *ad hoc* emergency conditions, is desirable for any long-range *planning* of objective applied research. This may lead to a certain amount of untidiness of the pattern of an organisation but all countries contended that such untidiness should not be regarded as a disqualification. In fact, the delegates from the United Kingdom were rather proud of the untidiness of their scientific organisation.

In any rapid expansion of scientific research on the other hand, there is an inherent danger that persons not suitable for research may occupy positions of vantage, from which it may be difficult to replace them afterwards, efficient or not, they camp on their jobs for years, thus frustrating the very objective of their initial recruitment.

2. Planning of research should be strategic and not tactical.

In his Opening Statement to the British Commonwealth Scientific Official Conference, the Lord President of the Council stated:

> 'There is one guiding principle I think you should adopt in approaching your task. It is that you should first of all consider carefully what you want to achieve and then consider how the desired results can best be brought about and what additional machinery, if any, is necessary for the purpose.'

Thus, irrespective of individualities, we should be guided primarily by the purposes to be served, and that is one reason why we should first of all be sure what we want to achieve.

Both the Lord President and the President of the Official Conference instituted an important distinction between subjects on which work can safely be left to develop along its own lines and those subjects in which a concerted attack is necessary.

These are very sound principles indeed for evaluating the merit of a programme of research and, therefore, all tactical moves to credit or discredit the work of a scientist in a Committee meeting should be subordinated to national needs and requirements.

3. Development of scientific research attains its best stature, if correlated with the traditions, and immediate, near-future and distant-future requirements of a country. Thus each Dominion has an independent pattern of organisation and is working along the lines chalked out by its scientists according to its special needs and requirements. Stress was laid on the fact that:

(*a*) Each country has its individuality and, therefore, it can never benefit by blindly copying the organisation of any other country, however advanced it may be;

(*b*) In any plan of scientific research and development, a knowledge of and experience in the working of local resources, and of the preferences of the peoples concerned are as important as scientific knowledge and technical skill.

In this connection, it may be well to recall the most illuminating observations made by Sir Edward Appleton in his Opening Statement to the Official Conference. He stated:

> 'I did not find the differences in the D.S.I.R. and C.S.I.R. organisations in any way alarming. In fact, I feel they may be a good thing. It is quite clear that the organisations are all doing good work, and are well suited to their tasks; and, what is more important, all of them seem to have flexibility to tackle the variety of problems with which they are faced. *After all it is not so much the administrative organisation of science, but the atmosphere in which scientific work is carried out, which really matters*; and as long as the scientist is in control of the conditions under which he and his staff work we may be quite sure that the maintenance of the right atmosphere will be assured. I should say that it is far too early to decide what the ideal Government organisation for research should be, and the machinery for fostering scientific effort must remain for many years in a state of active development. I feel sure the force of that will appeal to a gathering of experimental scientists.' (Italics are mine.)

The Government of India *now* keen on establishing perfect scientific organisations in the country should read and re-read Sir Edward Appleton's remarks and should set up a Committee to investigate whether the present-day Indian scientist is creating the right atmosphere for scientific research or in the lust for highly paid new jobs he is spoiling the atmosphere that had been created and fostered by the pioneer European and Indian scientists. It is a matter that deserves the most earnest attention of the nation, for there is a risk, as the Lord President of the Council pointed out, 'that too elaborate organisations may result in absorbing into the administration machine many scientifically trained men who are badly needed in research laboratories, Government laboratories or industrial laboratories. *We do not want to see too many scientific men transferred from their laboratories into offices.*' (Italics are mine.)

Sir Edward Appleton asked a very pertinent question in his Opening Statement: 'How far can a Government research establishment be allowed to grow without a resulting risk of sterility?' Unfortunately, so far as I recollect, this matter was not discussed, but Sir Edward indicated that 'in Great Britain we have tried to avoid the danger by budding off new establishments from existing ones when the case for it has become clear'. Sir David Rivett was of the opinion that the size of an organisation was immaterial provided the individuals and groups of workers were loosely linked within the organisation and allowed full freedom of action for their scientific work.

It is time that India paid some attention to the hurried and top-heavy planning, samples of which one sees every day in the press. The question for serious consideration is not how much money we are going to spend, but what are our definite objectives for which it is going to be spent and what is the scientific ability of the persons who are going to be entrusted with these expensive schemes of development.

4. Fundamental scientific research should be fostered by making adequate grants to Universities, private Research Institutions and Societies, so as to ensure continuity of scientific research and to irrigate properly the fields from which

research staff for development in industry and Government sponsored projects could ultimately be recruited.

In view of the importance of Universities as training centres, it is a matter of deep regret that to man Government scientific departments, the Universities in India are being denuded of their best men, who are naturally attracted by the high salaries offered by Governments.

Sir Edward Appleton voiced the feeling of the Conference when in his Opening Statement he remarked:

> 'It is specially important at the present time in view of the report of the Barlow Committee on scientific manpower which recommends that, in making the best use of our limited supply of scientists, the order of priority in this period of reconstruction should be
>
> (1) Teaching and Fundamental Research;
> (2) Civil Science, both Government and Industrial;
> (3) Defence Science.'

The Royal Society Conference emphasised the importance of small University units as spearheads of scientific progress, the great advantage of which is that they can be disbanded when their useful purpose has been achieved. Through a constant flow of fresh, young scientists, who pass through the Universities year after year, an independent scientific worker maintains scientific health and freshness of outlook which are generally lacking in Civil Science and Defence Science. 'We have all seen and admired', said Sir Edward Appleton, 'the wonderful work done by University scientists during the war when they left their academies and joined our Government Departments. It has been said that the reason for their outstanding success was that "it never occurred to them that it couldn't be done". I agree that was one reason, but I rather think there were others. But what cannot be doubted is that University conditions certainly do, somehow, generally ensure the maintenance of mental adventurousness and lively imagination so necessary for scientific progress.'

In view of what is stated above, India's greatest need at present is to strengthen its scientific research organisations in the Universities and in private institutions of University rank. The large amount of money that has been spent and is being spent in training Indian students abroad would have yielded permanent benefit if research organisations in the country had been strengthened with that money. The policy of starving research in the Universities and of depriving them of their able scientists must be given up in India for the period of reconstruction at least.

5. So far as India is concerned, unhealthy distinction between official and non-official science must disappear—the sooner the better. It was indeed a most regrettable feature that Indian delegation, as a whole, had no 'Leader', whereas among the delegations of the United Kingdoms and Dominions there was oneness of science and no apparent friction between official and non-official science. It would seem an imperative duty of official scientists in India to make a definite, concerted and conscious effort to raise the dignity and prestige of the independent University scientists, thereby making scientific research independent of political, personal, racial or communal considerations. It can be readily understood that official organisations are liable to vary considerably in their relative importance and popularity, both according to the political make-up of the Government and idiosyncrasies of the head of the organisation.

In support of my contention, I may be permitted to quote again from Sir Edward Appleton's Opening Statement. He observed that

> the Royal Society Conference has naturally been an opportunity to hear the point of view of the independent scientific worker but I think that the discussions have also demonstrated very clearly that the methods of scientific research are the same whether the research worker is carrying out his work in a

University or Government Laboratory or even in an Industrial Laboratory. In other words it has emphasised that science is one and indivisible.'

He also felt strongly that 'we as Official Scientists should not hesitate to do all we can to convince our Governments, where this is necessary, of the importance of the proposals for the extension of facilities for independent fundamental research at Universities throughout the Commonwealth'.

6. In planning scientific research and industrial development, it was felt that the most important essential commodity was trained men. It was considered desirable that, so far as possible, primary training up to Doctorate Degree should be in the country of origin of the person and that foreign training could be most useful when a person had already some knowledge of local problems and local resources. In this connection, the establishment of the Imperial Chemical Industries (India) Fellowships and National Fellowships awarded by the National Institute and tenable in the Universities and research institutions in the country constitutes a step in the right direction which may lead to a better organisation of science in the Universities and research institutions.

7. Interchange of University professors, Government scientists, scientists working in private institutions, etc. among the different institutions of the same country or among different parts of the British Commonwealth will lead to a concerted effort at developing the resources of the Commonwealth and better understanding the needs and requirements of its constituent parts. So that the exchange can be effective and productive of good results, it should not be less than of one year's duration.

So far as India is concerned, there has been mainly one-way traffic. India has invited from time to time a large number of foreign scientists and has no doubt gained by their visits. From discussions, it became abundantly clear that Indian scientists of today could contribute materially, particularly in biological sciences or applied branches of science based on biological data, to the betterment of other parts of the Commonwealth, provided they were given the same facilities which India has so far provided to foreign scientists.

8. While dealing with Information Services, it was felt that at the present moment a vast amount of scientific knowledge, which could have immediate application were it known to the men on the job, needs sifting, codifying and collating. This must be particularly true regarding India, where earlier scientists and travellers sometimes recorded their valuable observations in all kinds of odd books and journals in all parts of the world and which are not readily available to an Indian worker in any home library. In the case of fishery science, I have been pressing before the Fish Committee of the Imperial Council of Agricultural Research the need of such a codification of the literature on Inland and Marine fisheries for several years.

In the above notes, I have given a brief account of my general impressions with comments on the needs of India. I have purposely refrained from dealing with the social aspects of these Conferences. For instance, the friendly atmosphere that prevailed and the willingness of workers from all parts of the British Commonwealth to discuss problems of mutual interest outside the Conference rooms were most commendable. I think that one of the things I have most appreciated during these Conferences has been the opportunity to get to know our colleagues from different parts of the British Commonwealth. It should be our endeavour to keep up these personal contacts, to which all delegates attached the highest importance. A large number of evening informal discussions on a great variety of subjects at the Royal Society Empire Scientific Conference served a very useful purpose in fostering and strengthening these personal contacts. I think it will be worth while for the Indian Science Congress Association to arrange for such informal discussions, besides arranging popular public lectures at its annual sessions.

SPECIFIC CONTRIBUTIONS.

Under this title, I wish to comply with the request of the President regarding (i) important papers, read or discussed, as have a bearing on Indian problems and (ii) any paper contributed by myself to any of these Conferences jointly or individually.

At the very outset, I wish to point out that no one interested in pure fundamental zoological or fisheries research was represented at any of the Conferences, though various branches of applied zoological research discussed from different angles received considerable attention. For example, under 'A survey of some outstanding problems in agricultural science in the Empire', it was felt that animal physiology on a general basis and including all the chief domestic animals should be specifically studied. It was also felt that more knowledge was required of metabolism and enzyme systems of spermatozoa and ova. In discussing 'The etiology and control of infectious and transmissible diseases', the Royal Society Conference stressed the great need for acquiring more knowledge of the ecology of arthropod vectors of infectious diseases. In several other morning and evening discussions, references to applied aspects of Zoology, such as Entomology, Helminthology, Protozoology, Fisheries, etc., were fairly frequent.

Fisheries Papers read at or communicated to the Royal Society Empire Scientific Conference.

In the programme of the Royal Society Empire Scientific Conference, two papers were read which dealt with certain aspects of fisheries. In giving an account of 'Natural Products of the Empire and the Chemical Industries that are or might be based on them', Professor E. J. Hartung, Professor of Chemistry, University of Melbourne, referred to Seaweeds and Fisheries of Australia. From the point of view of India, the most significant observation he made was that 'it seems clear, however, that development and exploitation must proceed on lines rather different from those which have been successful in European Waters'. What is true for Australia is also true of India in a much greater measure. We have to evolve, through exploration, experience and experimentation, methods of fisheries development most suited to Indian waters.

The second paper, of which a summary was circulated, dealt with 'Food from Colonial Fisheries' by Dr. H. H. Brown, Director of Fisheries Investigations, West Indies. Observations contained in this paper are of particular interest as most of the Colonial Fisheries Waters are similar to those of India and the problems of exploration, exploitation, preservation and marketing need similar treatment. The whole of Dr. Brown's admirable summary is worth quoting but I wish to stress here the coincidence that, like Professor Hartung, Dr. Brown also favoured development of fishery methods *under local* conditions which need not be wedded to those familiar in the United Kingdom. He stated:

> 'It is necessary in each Colony to catalogue the resources available, and this, in the long run, can only be done by direct methods of fishery exploration. Both the scope of the fishery resources, and the methods by which they may be made available, must be explored in the most practical manner by working over hitherto unexplored areas, and by trying every kind of fish-catching technique which can be brought to bear, using not only those methods which are so familiar to us in this country (e.g. the otter trawl, long lines, etc.) but also methods which have been successful under conditions more closely analogous to those in the Colonies (e.g. the purse-seine in Norway, Pacific Coast of North America, Japan, or multiple trolling in Brittany, Pacific Coasts, Japan).'
>
> 'The same principles apply also in the field of fish preservation—on ice, under cold storage, or by wet or dry salting. Methods require to be adapted on

the spot to the often trying conditions of temperature, humidity, fuel and power supply, etc.'

Dr. Brown's paper was presented to the meeting that discussed the present state of the science of nutrition with particular reference to the special problems of the Empire, including the nutritional status of the indigenous peoples of the colonies and the following resolution was adopted:—

'4. Increased production of the protective food through:

(b) increased and improved fishing operations with the following general objectives:

(i) fishery exploration and fish-catching (fishery engineering);
(ii) fish processing and technology;
(iii) fishery biology and hydrography;
(iv) development of great lake fisheries together with fish culture in fresh and brackish waters.'

The above recommendations have a great bearing on the fishery problems India is facing at the present moment and it is hoped that views of the Conference will receive due consideration in formulating any long-range plan of fisheries development in India.

Other Oceanographic and Fisheries papers not read but circulated at the Royal Society Empire Scientific Conference were the following and all of them have bearing on allied problems in India:—

1. Cameron, A. T.—Technological Research at the Experimental Stations of the Fisheries Research Board of Canada, and its application in industry.
2. Hefford, A. E.—Modern Scientific Aids to Fishing Operations.
3. Hefford, A. E.—Oceanography of New Zealand Seas.
4. Rapson, A. M.—Chemical Hydrology of New Zealand Land Waters.

Contributions made by the author to the Royal Society Empire Scientific Conference.

Lectures.—I was invited by the Royal Society to open an informal discussion at Cambridge on any subject dealing with fisheries. In view of the great possibilities of pond culture in India, particularly Bengal, Assam, Bihar and Orissa, and the lack of knowledge on this subject in certain parts of the British Commonwealth, I undertook to speak on 'The rôle of the village pond in the rural economy of India'. The lecture was delivered on the 26th of June and was illustrated with lantern slides and a film on 'Fish Cultural Practices in Bengal'. The Royal Society had issued invitations to fisheries research institutions in the United Kingdom to participate in the discussion and the response was very good. After a discussion on the above subject, a further informal discussion on fishery and oceanographic problems in general was held, 36 fishery scientists being present at the meeting. It was resolved to recommend that

> 'The oceanographic and fisheries scientists present as delegates to the Royal Society Empire Scientific Conference request its Steering Committee to arrange that if possible a meeting be called during the period of the British Commonwealth Scientific Conference of these delegates, and other specialists available in this country, to discuss methods for co-operation and co-ordination of fisheries and oceanographic research within the Commonwealth, and similar matters of common interest.'

This recommendation was accepted and a meeting of the Oceanography and Fisheries Committee was held on July 16 and 17, 1946. A brief account of this meeting is given later.

I had suggested to the Royal Society that a discussion on 'Fish Culture and Malaria Control' may be useful at the Conference. Though there was a crowded

programme of informal evening discussions, the requisite number of delegates having signified their assent for holding a discussion on this subject, 3rd July, 1946, at Oxford was allotted for it. After discussion, the following recommendation was made:—

> 'In view of the great possibilities of utilising ponds for fish culture in various countries of the Commonwealth where malaria is prevalent, the Conference proposes that the attention of governments of countries so situated should be drawn to the urgent need of integrating fish culture practice with measures for malaria control.'

Copies of both the lectures were duplicated and circulated to the delegates of the Conference and at the Oceanography and Fisheries Committee meeting.

Papers.—Papers on the following subjects were prepared for the Royal Society Empire Scientific Conference and sent to Delhi before the 31st of March, the date fixed for the submission of papers, but for some reason they had not reached the Royal Society when enquiries were made in London about the 10th of June, 1946.

1. Rôle of Fisheries for the Improvement of Nutrition of the Indian People.
2. Agriculture, Animal Husbandry and Fishery as correlated industries.
3. Submarine Surveys and the Location of Fish.
4. The Fundamental Problems of the Fishing Industry.

The first three articles will now be published elsewhere, while the third was duplicated by the British Commonwealth Scientific Official Conference and circulated as O.C. 72.

British Commonwealth Scientific Official Conference.

The Working Party of the Conference did splendid work in the preparation of papers (Green Book) in advance of the Conference and these had been circulated to the delegates for comments and suggestions. There were three subjects on which comments were offered by the writer, namely, Food Investigation Organisation, Water Pollution Research Laboratory and Fisheries Research Organisation. Short comments on the first two items were circulated as O.C. 14, while comments on Fisheries Research are embodied in O.C. 11 entitled 'Fisheries Research in India'. All these papers as well as a note on 'Oceanography in the Indian Ocean' (O.C. 62) were placed before the Oceanography and Fisheries Committee for discussion. It was also my intention to raise a discussion on 'Fish Farms: Objectives and Requirements' but time could not be found for it. The paper had previously been published in the *Journal of the Royal Asiatic Society of Bengal.*

Oceanography and Fisheries Committee.

It has been referred to above that at the recommendation of the Fisheries and Oceanography scientists, it had been decided to institute a Committee and accordingly on the opening day the Chairman announced the formation of this Committee with Dr. H. H. Brown as its Secretary. Its terms of reference were

> 'To consider questions on collaborative research and such other topics as may be referred to them by the Conference, and to report.'

Even long before the Cambridge resolution, Dr. Brown and I, with the help of Mr. W. L. Francis, one of the Secretaries of the Official Conference, had planned a Specialist Conference, and accordingly invitations were issued to all Oceanography and Fisheries scientists known to be resident in the United Kingdom at the time. His Majesty's Government very generously undertook to bear the travelling and board and lodging expenses of all such persons. In spite of short notice, the meeting, which was held on the 16th and 17th July, was attended by over 40 scientists. India was well represented by Dr. J. T. Jenkins, Dr. James Hornell, Lt.-Colonel R. B. S. Sewell, Dr. C. Amirthalingham, Mr. M. Afzal Hussain, Dr. B. C. Guha and myself. Among other members who had personal experience of the East were Dr. G. A. C. Herklots (Hong Kong) and Mr. L. Birthwistle (Malaya). Several other fishery

scientists had practical experience of the working conditions in Tropical Africa and the West Indies. The Committee had four sessions at which the following business was transacted.

On the 16th morning (10 a.m. to 12-30 p.m.), the Committee met under the Chairmanship of Dr. A. T. Cameron, Chairman, Fisheries Research Board of Canada, to survey some of the outstanding problems in Fishery Science and Oceanography in the Commonwealth. Dr. Deacon introduced the subject of Oceanography, Colonel Sewell gave a brief account of the Indian Ocean and its problems, Dr. Carruthers dealt with a few present-day aspects of Oceanography and Dr. Cameron mentioned the programme of oceanographic work likely to be taken up by Canada. In a discussion on Fishery science, Mr. Graham outlined some general problems of North-West Europe and the following speakers gave a brief account of the investigations they had conducted in different parts of the Commonwealth: Dr. Smeath Thomas (South Africa); Dr. Wheeler (South Georgia, Bermuda, Mauritius and Seychelles); Dr. Cameron (Canada); Dr. Mackintosh (Southern Ocean); Mr. Birthwistle (Malaya); Dr. Worthington (Fresh Water: United Kingdom and East Africa) and Dr. Hartung (Australia).

The afternoon session (2-30 p.m. to 4-30 p.m.) was held under the Chairmanship of Colonel Sewell for discussing modern methods of Oceanography, of Fishery Exploration and Development and Fisheries Technology as applying to the fisheries of marine, brackish and fresh waters. Dr. Deacon gave an account of the modern methods of oceanographic research while Dr. Carruthers dealt with Current Metres. In the discussion on Fishery Exploration and Development, Dr. Hora referred to the methods applicable to Indian conditions; Dr. J. E. Hamilton gave an account of the Fisheries Development in the Falkland Island; Dr. Trewavas stressed the importance of Taxonomy in fisheries development and Dr. Herklot strongly pressed for an efficient marketing organisation for the development of fisheries. The various aspects of Fish Technology were dealt with by Dr. Cameron, Dr. Lovern and Dr. Guha.

In the morning session on the next day, under the Chairmanship of Dr. B. C. Guha, Dr. Brown initiated a discussion on present methods of circulation of information, statistical and general, on the scientific and economic aspects of Oceanography and Fishery resources and production, and of possible means of their improvement. Dr. Cameron, Dr. Bertram, Dr. Herklots, Dr. Hora, Mr. Russel, Dr. Carruthers and Sir David Chadwick took part in the discussion.

The afternoon session under the Chairmanship of Dr. Cameron was devoted to drawing up recommendations to be placed before the Official Conference. With slight modifications, the Conference accepted the recommendations and an organisation has now been set up which will call such specialist Conferences at regular intervals in different parts of the Commonwealth. A copy of the resolutions is given below for ready reference.

Recommendations of Committee on Oceanography and Fisheries.

The Committee

1. Endorses recommendations of the Royal Society Empire Scientific Conference C, 3 (improved methods of processing of fish) and C, 4(*b*) (increased production of 'protective foods' through increased and improved fishing operations).
2. Recommends that the Commonwealth countries should pay particular attention to the need for long-term research in Fisheries and Oceanography, especially in regard to the problems of water circulation and its fluctuations. The Committee also recommends that regional cooperation should be aimed at in the organisation of such research.
3. Recommends that wave recording stations should be established especially in Commonwealth countries bordering on the same ocean, to permit

collaborative investigations of sea and swell conditions in view of their importance in studies of meteorology, coastal erosion and problems related to breakwaters, harbours, etc.

4. Urges on the Governments of the countries bordering on the Indian Ocean the desirability of close *co-operation in studying the* Oceanography of that ocean. It suggests that such co-operation might be greatly facilitated by the establishment of one or more institutes of Oceanography in suitable locations jointly supported by the Governments concerned.
5. Recommends that such oceanographic and fisheries research as is not world-wide in its nature should be co-ordinated within the regions specially concerned, since this would lead to increased efficiency and economy in man-power.
6. Stresses the necessity for the dissemination of information on Oceanography, Limnology, Fisheries research and technology to the workers in those fields and especially to the isolated research workers in the colonies and elsewhere. The Committee suggests that possible agencies which might be considered for this purpose are those of the United Nations Organisation, the Imperial Agricultural Bureaux and the British Commonwealth Scientific Offices. The Committee further requests that the standing Committee of the British Commonwealth Scientific Conference examines these suggestions and devises a suitable scheme to care for the isolated scientific worker.
7. Would welcome the establishment of a Journal for Colonial Fisheries and Oceanography.
8. Recommends that the Standing Committee should consider the advisability of calling a specialist Conference on Oceanography and Fisheries within the next three years.

These recommendations deserve the closest consideration by the Government of India not only in organising fisheries research in the country but for establishing contacts with countries bordering on the Indian Ocean or in the Pacific Region having similar fishery problems.

CONCLUSION.

Speaking for myself, I can say with confidence that these Conferences had a great educative value for me. My only regret was and will always remain that the programme was overcrowded and that the delegates had no time to digest very valuable literature that was being placed daily in their hands. The air travel, though a great boon in saving time, has one disadvantage; it brings you back to your routine administrative work in no time and then you can find no leisure to ruminate and digest important recommendations of such conferences. If I had an opportunity to travel back by sea, I would have been in a better position today to place more detailed information concerning these Conferenees before my colleagues in India.

One cannot close this account without referring to the great effort and labour that must have been put by the organisers of the two Conferences and their staff. The arrangements were simply perfect and marvellous. The success achieved by these meetings reflects the thoroughness of the preparations and must have been a source of great pleasure to the organisers. We are extremely grateful to His Majesty's Government for their kind hospitality and to a large number of persons in London, Cambridge and Oxford for their manifold kindnesses and courtesies.

Government of Bengal

Directorate of Fisheries

Fishery Development Pamphlet No. 2

Culture of Katli, *Barbus (Lissochilus) hexagonolepis* McClelland, in the Darjeeling Himalayas

By

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Possibilities of Fish Culture in the Eastern Himalayas

By SUNDER LAL HORA, D.SC., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I., *Director of Fisheries, Bengal.*

Southwell (1915, p. 16) dealt with the possibilities of Trout Culture and improvement of Mahseer fishery in the hill streams of the Darjeeling Himalayas and came to the conclusion that whereas Trout Culture was impossible, measures could be taken to improve the Mahseer fishery by stopping prevalent malpractices. That some improvement in the fisheries of these hills is desirable will be obvious when one is faced with facts that at present fresh fish is hardly ever obtainable by thousands of coolies working on the estates and even by a large number of well-to-do people who frequent these hills for recreation and health. This being so, we may now consider the possibility of adopting certain measures for the improvement of fish supply for the people of these hills.

Present position of supply and demand.

Local production.—At present only a very small quantity of local fishes, mostly *Asla* (*Oreinus moleswortkii*) and *Katli* [*Barbus* (*Lissochilus*) *hexagonolepis*], is sold surreptitiously in Darjeeling, Kalimpong, Gangtok, etc., and whatever quantity is thus brought up gets a ready sale. The supply being totally inadequate and the demand at tea shops being great, the prices are always fairly high. By judicious exploitation under a licence system, improvement of breeding and feeding grounds of fish and adequate enforcement staff to ensure protection to the immature fish, the natural supply could be increased by several hundred per cent. within a short period.

Imports.—It is true that a certain quantity of fish is imported into Darjeeling, Kalimpong and Gangtok from fishing centres in Bengal and Bihar, but one must remember that fish sold in these markets are usually not absolutely fresh and that sometimes, owing to the late running of the trains or road blocks, the whole consignment may go bad. Further, under present arrangements, fish reaches the consuming centres in the afternoon and has to be kept over for sale on the next morning. In the absence of suitable refrigeration facilities, the fish often deteriorates still further, but as the demand is heavy, especially during the season, the business is good. Now with the cessation of hostilities and likely extension of refrigeration facilities, the prospects of getting increased supplies from down country would appear to be bright and it may safely be presumed that some local merchants will be able to make suitable arrangements with the Mail Bus Service for transport of fish in properly insulated fish boxes.

Unless quick frozen fish industry comes into existence in Bengal, it must be admitted that the consumption of fish in a fresh condition is necessarily limited to the immediate neighbourhood of production. Fish, as we all know, is not only more susceptible to putrefactive action than flesh but cannot ordinarily be brought to market without some hours of delay after death, and often after considerable exposure to various causes of decay. Such fish, even when preserved in ice, loses its flavour and food value depending upon the condition of its arrival in the market. It is for these reasons that in spite of advances in refrigeration and chemical preservation, keeping of fish alive is far more largely used than is supposed to be in every European country, America and Japan. It is significant that though Norway has a cold and even sub-arctic climate, the use of live chest and car for keeping fish alive is very common. It is stated in a "Pamphlet on the Sea Fisheries of Ireland" by Rev. W. S. Green (1888) that "The difference between the prices of living and dead cod in Billingsgate and other markets is very great, cod brought alive in well-boats fetching often 140s. per score while from 60s. to 30s. is the value of dead fish on the same day". In India, particularly Bengal (*vide* Hora, 1934) preference

is shown for *Jiol* (*live*) fish, such as *Murrels, Koi, Magur, Singi*, etc., for the same reason and the prices of dead and living specimens of these kinds show marked differences. There is also a practice in Bengal to tow live fish, particularly *Bhetki* (*Lates calcarifer*), from distant places in the Sundarbans to fish assembly centres and sometimes even to Calcutta in split bamboo cages. It is obvious, therefore, that no preserved fish can replace in quality absolutely fresh fish. The Directorate of Fisheries, Bengal, has, therefore, given the highest priority to make fish cultural practices popular so that like kitchen gardening, pond culture becomes a national asset for the fortification of public health.

Fish culture.—Except by a few individuals as a hobby, fish culture is not practised as a commercial proposition by any one in the hills, though this is the only way by which supplies of fresh fish can be increased within a short period by several times. It is little realised that "Natural sites for ponds are easily found on broken, waste lands, thus providing a means of utilising waste land, marshy land, derelict water-meadows, gullies and ravines. Depressions in the ground, a succession of shallow little valleys or ravines, muddy water-holes, all make excellent ponds, and by skilful use of the levels in undulating land, ponds can be constructed without much expense or labour. A number of small, shallow ponds is much to be preferred to one or two large ones. From the point of view of economy it is best to construct ponds which require little digging out and a minimum of artificial banking" (Hall, 1930, p. 7).

Suitable varieties of fish for pond culture.

Trout culture.—It has already been pointed out that Southwell considered trout culture in the Darjeeling Hills impossible, but since his time attempts have been made to acclimatise Brown Trout in these hills for sport by Colonel F. M. Bailey, the Darjeeling Shooting and Fishing Club, His Highness the Maharaja of Sikkim, Sir B. J. Gould and Raja Dorji of Bhutan. Sir B. J. Gould has already published a review of all such attempts and shown how the fish has now established itself in the Ha Valley in Bhutan at an elevation of about 9,000 to 10,000 feet. The rapid rise and fall of rivers, the large quantity of silt they carry during floods and the precipitous nature of the valleys with high waterfalls preclude the establishment of trout in the rivers of the Darjeeling Himalayas though it may be possible to keep a few individuals in ponds at higher altitude. From the standpoint of increased food supply, trout culture must still be regarded as uneconomical.

Katli culture.—After seeing Mr. W. K. Langdale Smith's Katli Terraced Ponds at Runglee Rungliot, I became fully convinced that the culture of Katli was possbile in the Eastern Himalayas provided a suitable lie of land for a series of ponds could be found and a regulated supply of water to run through them could be diverted from a stream. This belief was further strengthened by the fact that males ranging in length from 91 to 167 mm. were found with mature gonads in September 1942 in the small streams of the Teesta Valley (Hora and Nair, 1943), and later Mr. Langdale Smith's (1944) observations on the breeding habits of Katli confirmed this.

Thus *a priori* Katli seemed a very suitable fish for culture both on account of the ease with which it could be bred and its omnivorous feeding habits (Hora, 1940, p. 86; Hora and Nair, 1944, p. 158). For cultural operations, therefore, besides the construction of ponds an assured seed-supply was considered essential and accordingly arrangement was made with Mr. Langdale Smith to intimate to me by telegram as soon as Katli showed spawning tendencies in his ponds. He very kindly sent a telegram on the 2nd August 1945, but as I had other urgent engagements, Dr. Nazir Ahmad, who had considerable experience of studying the life-histories of the Punjab fishes (1944) was sent up for investigations. Dr. Nazir

Ahmad's researches have now ushered in a new era in the history of fish culture in India as he has been able to strip and successfully nurse the baby fish to a fingerling stage. From the next year, it will be possible to maintain a departmental fish seed depot and to advise about the culture of Katli. It is hoped to make fish culture in the hills a popular hobby and thereby produce a large quantity of fresh fish.

Katli is similar to Mahseer fish and weight for weight there is nothing to choose between them as sporting fish. For the systematics and bionomics of Katli reference may be made to Hora, 1940.

Other suitable fish.—Besides Katli, there are two species of Mahseer, *Barbus* (*Tor*) *putitora* and *B.* (*Tor*) *tor*, which Mr. Langdale Smith has been keeping in his big pond for years. While the former species is predatory in habits, the latter has been found to feed on weeds and grow fairly fast in captivity. Attempts will be made to investigate the cultural possibilities of these two species. The two species of *Labeo*, *L. dero* (Hamilton) and *L. dyocheilus* (McClelland), known as *Gurdi* or *Goddi* grow to a good size and are very good eating. These are bottom feeding species and attempt will be made to investigate their cultural possibilities. *Asla*, *Oreinus molesworthii* Chaudhuri, is another species which can be readily domesticated and has been found to breed in ponds. The programme of fish culture in the hills will include a close study of this species also. As in the case of the carps of the plains, it may be possible to establish a zonation of species feeding at different levels in a hill pond.

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On the Spawning Habits and Culture of Katli, *Barbus (Lissochilus) hexagonolepis* McClelland.

By NAZIR AHMAD, M.SC., Ph.D., *Superintendent of Fisheries, Bengal.*

So far as I am aware, no attempt has yet been made to culture any indigenous species of fish in the hills of India on a commercial scale. It is well known, however, that hatcheries have been set up for Brown and Rainbow Trouts in the Western Himalayas, Bhutan, Nilgiris and Travancore Hills and great care has been taken in propagating these exotic species to provide sport to anglers which is an expensive hobby. How far the culture of trout has added to the food resources of the country it is difficult to estimate, for Brown Trout is a predaceous fish and must have replaced indigenous fish fauna wherever it became established in natural streams. The circumstances under which Dr. Hora became interested in the culture of Katli are fully explained in the preceding article. When on the 2nd August 1945, he received a telegram from Mr. W. K. Langdale Smith of the Runglee Rungliot Tea Estate that the Katli were breeding, he immediately sent me to study the life-history of the species and to explore the possibilities of starting Katli Hatcheries and Farms in the Teesta Valley. I am indebted to Dr. Hora for affording me an opportunity to investigate this interesting problem and to Mr. W. K. Langdale Smith and Mr. A. J. L. Lister for their manifold kindnesses and courtesies shown to me during the period of investigation at their estates.

Nature of spawning bed.

On arrival at Runglee Rungliot on the 4th August 1945, it was found that Katli were ready for spawning in the Katli Terraced Ponds (Plate I) of Mr. Langdale Smith and were restlessly in search of suitable spawning grounds. The big fish were kept in Tank No. III and on attaining maturity they moved up first into No. II and later into No. I. In tank No. I, only males and females indulged in amorous play and after sometime they either moved to the portion of the pond marked "X", where the depth of water was about 9 inches and the force of current extremely slow, or they moved towards the inlet marked "F". Movement towards "F" was not for spawning but for finding out new spawning grounds, while "X" seemed to be more favoured for actual spawning. Accordingly, the area marked "B" was improved and extended to facilitate spawning. The Katli actually spawned in the "X" area and probably also at "B" but the pond was full of fry by September.

It is interesting to note that though Mr. Langdale Smith (1944, p. 90) had never found fry in the lower and middle ponds, he had "no doubt the bigger fish do spawn in the bottom pond as you can see many patches in the spawning season cleaned up by fish in spawn".

At Pashok, there was only one tank (Plate 2) in which Katli had been stocked by Mr. A. J. L. Lister. It was fed by a narrow, irregular channel in which the fish did not ascend. The channel was widened and cleaned and at its upper end a spawning bed "C" was provided by covering the bottom with fine gravel. The fish then moved from the pond and played in the spawning ground and actually spawned there as well as in the shallow part of the tank, which had also been properly cleaned.

At Kalimpong, there was also a single tank (Plate 3) belonging to Mr. Narprosad Kumai with outlet and inlet in which Katli had been stocked. The feeding channel was long with a gravelly bottom. The fish ascended into the channel "D" and spawned.

It is reported that the young fry of 2″ to 3″ introduced by Dr. Hora and Mr. Nair in Dr. Sen's tank at Mungpoo in April 1943 bred in September 1945. The water flows into the tank through a precipitous channel and there is a very gentle outflow. The fish must have spawned in a shallow part of the tank itself. This would indicate that even in confinement, Katli begins to breed in the 3rd year of its life.

From the above, it would appear that the following conditions favour the spawning of Katli:—

(1) Comparatively still, shallow and calm water. The flow of water should be gentle and even.

(2) Even bed, covered with clean small gravel.

(3) Temperature of 70°F. or thereabout.

Breeding habits.

Having selected a suitable spawning ground, the female clears a portion of the bed of the overlying silt by a side to side movement of its tail. Though the female is attended to by 3 to 20 or more males, they take little part in this operation. The female makes several attempts by paying occasional visits before a portion of the bed is cleared to her satisfaction. When this is done, the female jerks its head to produce muscular movements of the body and the ova are shed. The males lose no time in shedding the milt over the ova. Sometimes the milt is discharged so lavishly that the colour of the water at places of incidence turns slightly milky.

Disparity in the sizes of breeding males and females.

Hora and Nair (1943) have already recorded that in the small streams of the Teesta Valley males become fully mature when they are only 91 mm. in length. Later, in a note on Mr. Langdale Smith's observations on the breeding habits of Katli, Hora (1944, p. 90) stated "It is now clear to us that the small size of the breeding males 4 to 7 inches in length, found by us in the Rambi, Riyang and Tista Rivers, is not due to any adverse effect of the affluent from the Cinchona Factory at Mungpoo but is the natural size at which the fish begins to breed." It was then observed that whereas males of 91 mm. in length had attained maturity, the females of 195 mm. in length showed that the eggs were just forming in the ovary.

The following statement of Mr. Langdale Smith contained in his letter of June 24, 1945, appears significant in this connection. He observed:—

> "I have now examined all three ponds in which the Katli were kept. The lower pond contained many Katli of from 7 inches to 5 pounds. The middle pond about a hundred from 5 inches to 9 inches in length. The top small pond had a few 6 inches Katli."

Mr. Langdale Smith has recorded August-September as the breeding season for the fish, but it would seem probable that males mature early and move towards the spawning ground earlier and wait there for the females to come in due course. I think the smaller specimens found by Mr. Langdale Smith in Ponds II and I towards the end of June may have been males. It will be interesting to make further observations on this point during the next breeding season.

Opportunity to study the sizes of mature males and females occurred when the fish were caught on the spawning grounds. For example, on

one occasion a female 15½ inches long was captured with 15 males from 5 to 11 inches in length. On another occasion, a female 14 inches in length was captured with 4 males from 5 to 7½ inches in length. On no occasion was a female measuring less than 9 inches in length seen in actual sexual play on the spawning grounds. It is now conclusively established that whereas males mature when they are small in size, the females rarely attain maturity under nine inches in size.

Whether the males become mature at an early age than the females it is not possible to say from the data available so far. It is possible, as is generally the case in a number of animals and in some fishes, that the males remain of a much smaller size than the females irrespective of age on account of some physiological factors not yet known. Any way, the smaller size of the males ensures their crowding all round the female and thus fertilising a very large percentage of ova. Next season, a census will be taken of the fertilised and unfertilised ova under natural conditions so as to test the hypothesis advanced above.

Enemies of Katli eggs and young.

Mr. Langdale Smith has surmised that the ova of the fish liberated in the lower pond are devoured by other fish before they come to anything. This is quite probable because in Mr. Langdale Smith's larger pond, where Mahseer are kept, Katli are often seen following gravid females discharging ova. It is likely also that the young ones are devoured by the larger fish though direct observations on this point are lacking. In Katli culture, therefore, young fry will have to be kept separate from the older fish, for some protection afforded by shallow spawning grounds may not be available in cultural ponds.

Several specimens of the carp Minnow, *Danio aequipinnatus* (McClelland) were found in Katli ponds and it was suspected that they must be destructive to the eggs. An experiment was conducted by introducing a number of freshly laid Katli ova in a bowl containing specimens of *Danio* and it was found that the eggs were readily devoured. It is obvious, therefore, that even such supposedly harmless species shall have to be excluded from hatcheries and nurseries.

Stripping of Katli.

As fish ready for spawning could be easily procured from the connecting channels between the ponds and the feeder channels at Runglee Rungliot, an attempt was made at stripping and artificial fertilisation of eggs. I stripped the females on the 8th and 9th August and fertilised ova by mixing fresh milt with them. Later on Mr. Langdale Smith tried with success the same experiment on the 24th August and 1st and 10th of September. I was able to do the same at Kalimpong on the 18th September. The mixed ova and spermatozoa were allowed to remain together for about five minutes before water was added to wash away excess milt. The fertilised ova were then transferred to improvised hatching trays which were kept in a shallow pool with a gentle, continuous flow of water. To protect the eggs from predatory animals and sunlight, the trays were covered with a lid. Later, Mr. Langdale Smith improved on this by keeping the hatching tray inside a big wooden trough so that silt could be avoided. Pebbles were placed both in the tray as well as in the trough and the former was used for hatching eggs while the latter for rearing fry. In this way, eggs and early embryonic stages were collected before I left the station but it became quite clear that artificial fecundation had yielded the desired results.

In fish cultural practices, the advantages of artificial fertilization are well known. Firstly seed supply for culture becomes readily available and

then the quality of the seed is also sure. As the main factor influencing the spawning of Katli appears to be a temperature of about 70°F., it is obvious that the fish become mature earlier in the valleys than on the hills. In fact its breeding season has been recorded to be May-June by some and August-September by others. By working at different altitudes, the same staff will be able to handle a large number of brood fish in the season.

Since the incubation period for the hatching of the eggs of Katli is about a week, it will be possible to arrange the transport of eyed-ova over long distances as is usually the practice in the case of trout. In fact, it may be possible to send this valuable game fish to all over the world where favourable conditions for its growth and multiplication exist.

Of the three species that will now become available for culture in the Indian hills, Katli will be found far superior as will be clear from the statements contained in the following table:—

Table showing the cultural possibilities of Trout, Mirror Carp and Katli.

Trout, *S. fario* and *S. irideus.*	Mirror Carp, *Cyprinus carpio* var. *specularis.*	Katli, *Barbus (Lissochilus) hexagonolepis.*
Exotic, imported from Europe.	1. Exotic, imported from Prussia.	1. Indigenous.
Cultivated in suitable places in certain hill tracts of India. Due to its specific requirements, its culture has not proved successful at many places.	2. Its culture has been started in South India. Experiments are being conducted to find out their suitability for cultural purposes in different regions of the presidency.	2. Naturally lives in Assam and Eastern Bengal hill streams.
3. Do not breed in tanks.	3. Breed in tanks.	3. Breed in tanks.
4. Can be stripped.	4. *Cyprinus carpio* cannot be stripped.	4 Can be stripped.
5. They do not make the water in which they live muddy. Being predaceous, most other fish cannot live along with them.	5. Make the water muddy and turbid by rooting about for food in the mud. Thus they destroy natural vegetation and make the water unsuitable for other fish.	5. Do not spoil water. Other fish can also live along with them.
6. Breed during winter.	6. Breed during winter.	6. Breed during summer.
7. Development slow.	7. Development comparatively slow.	7. Development fairly rapid.
8. Sporting fish.	8. Not a sporting fish.	8. Sporting fish.
9. Require artificial food, when kept in ponds.	9. Require artificial food, when kept in ponds.	9. Do not require artificial feeding.
10. Incubation period about a month or more.	10. Incubation period not definitely known.	10. Incubation period about a week.

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Explanation of Plates.

Plate 1.—Sketch showing the Katli terraced ponds at Runglee Rungliot. The waterfall is about 2 feet higher than the drain. The depth of ater on the 4th August was—

6 inches in the spawning bed "B",
9 inches in the spawning bed "X",
3 inches in the connecting channel between "B" and tank No. I,
2-2·5 feet in tank No. I,
3-3·5 feet in tank No. II, and
3-4 feet in tank No. III.

The connecting drains between tanks Nos. I and II and II and III, are placed in such a way that these pass across the longest length thus giving an easy gradient for fish to ascend. Moreover in each drain a pool (2′ × 2′) is provided where the fish can rest while on its upward march to the next tank.

Plate 2.—Sketch showing the Katli pond at Pashok. The water is coming from the overhead channel marked "F". The excess of water, which is not required for feeding the tank can be drained out by the drain "G". The spawning bed "C" gets water from "F" as well as an insignificant quantity of water from the channel "K". The tank also receives water by the drain "L", which connects this tank with another tank, situated at higher level.

The depth of water in the tank on the 7th of September 1945 was 1·5-4 feet as shown in the sketch, and 6 inches on the spawning bed.

Plate 3.—Sketch showing the Katli pond at Kalimpong.

The channel "D" is fed by a long narrow channel, measuring 84 feet in length. The fish move to "D" and spawn on the sides of the channel. The depth of water in the channel was about one foot and in the tank from 1·5-2·5 feet, on the 10th September 1945.

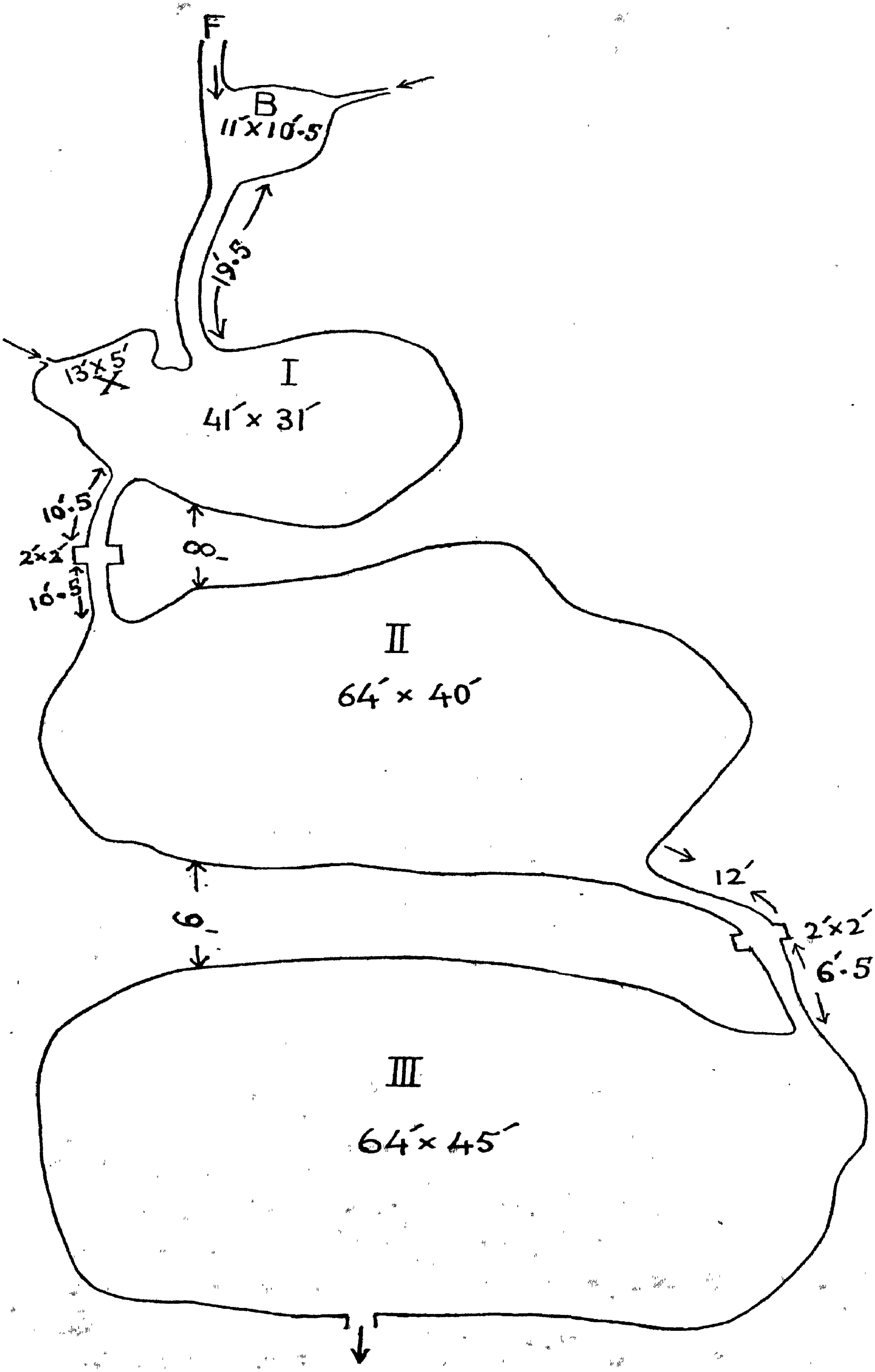

Plate 1.—Katli terraced ponds at Runglee Rungliot.

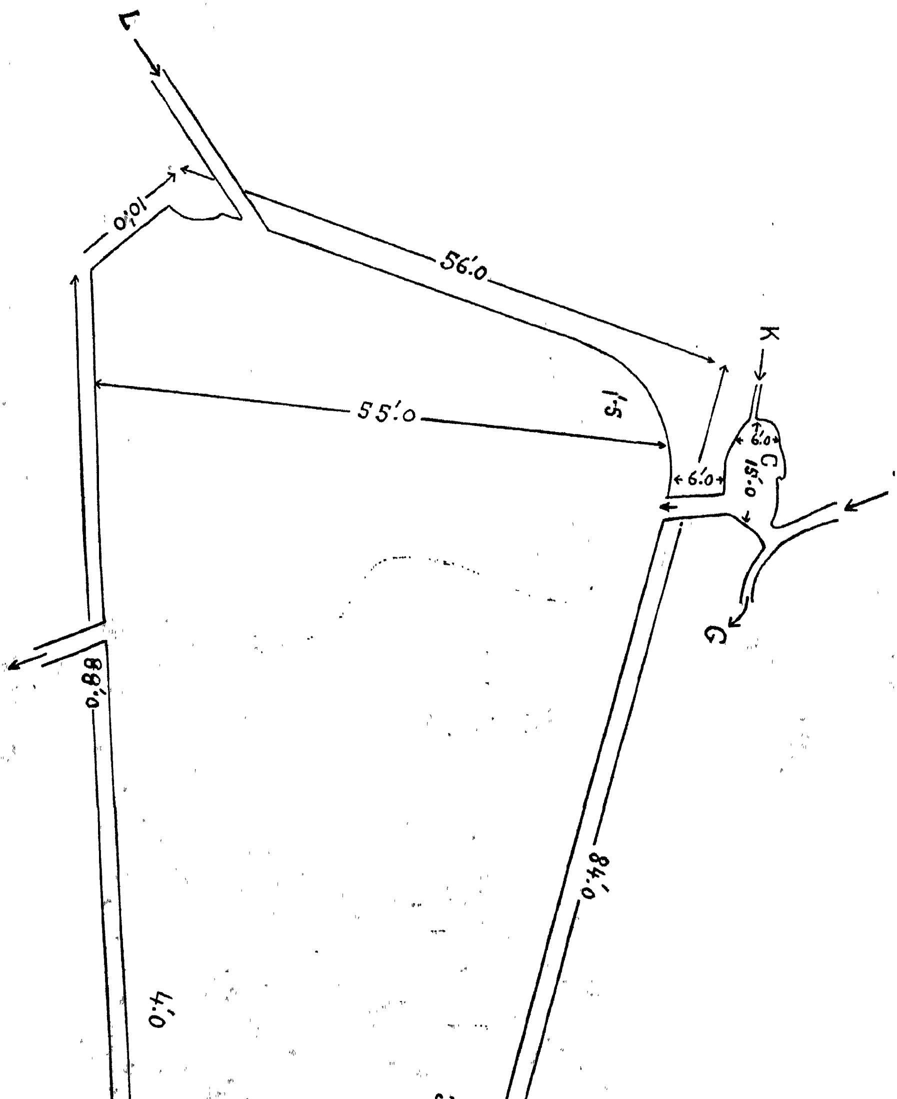

Plate 2.—Katli pond at Pashok.

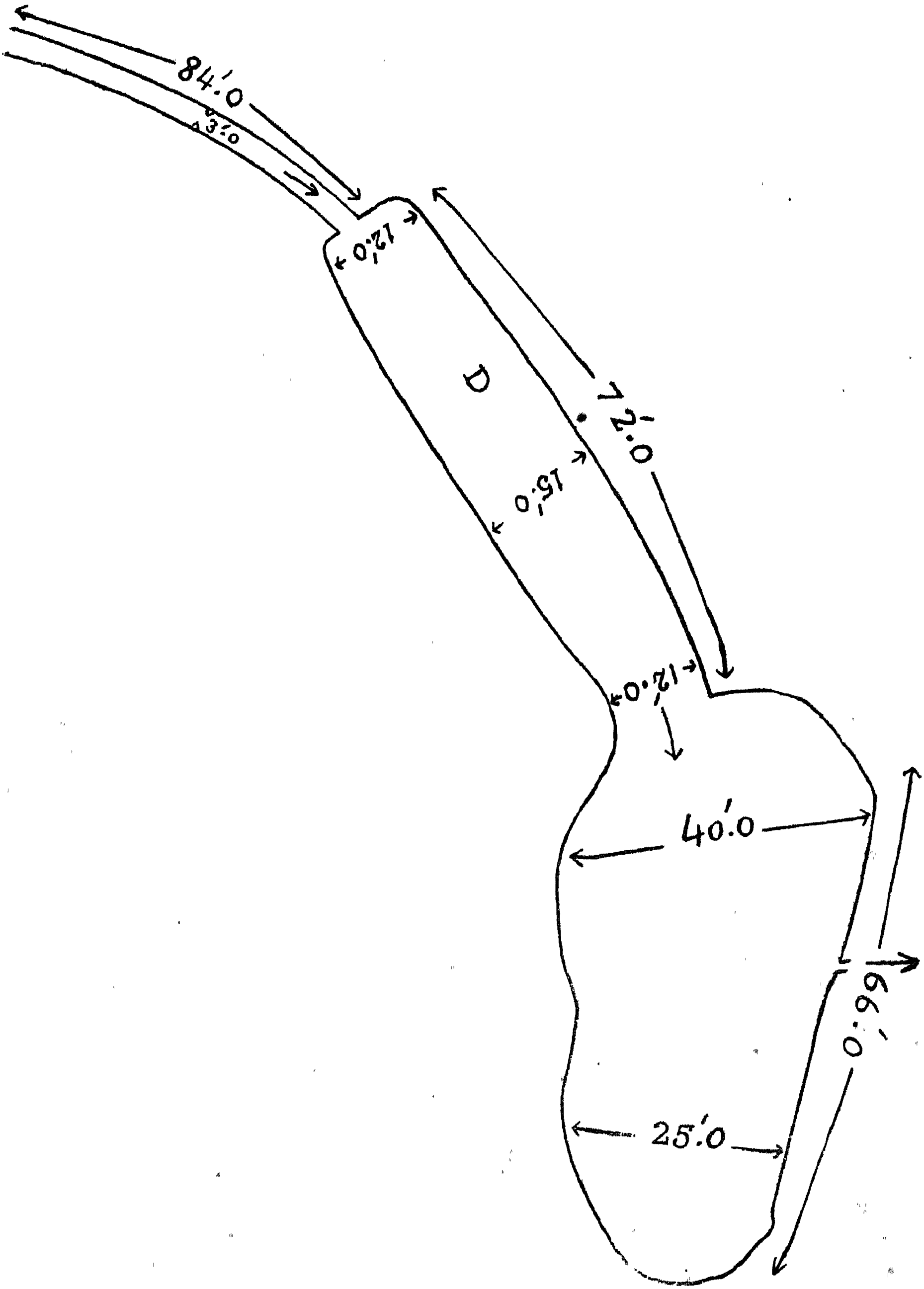

Plate 3.—Katli pond at Kalimpong.

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PHYSIOLOGY OF EXCRETION IN EARTHWORMS

IN an important memoir on the Physiology of Excretion in Earthworms (*Quarterly Journal of Microscopical Science*, Oxford, Vol. 85, Pt. IV, September 1945), Prof. K. N. Bahl of the University of Lucknow gives a very interesting and instructive account of his experiments and observations. He finds that the earthworm voids its excretory products as ammonia and urea and that there is no trace of uric acid in its urine. Ammonia and urea are first formed in the body-wall and gut-wall and are passed on to the blood and cœlomic fluid, whence they are eliminated by the nephridia. In fact, ammonia and urea have been estimated for the first time in the blood, cœlomic fluid and urine of an earthworm. Since the blood contains excretory products, the current view that blood is merely a carrier of oxygen has been proved to be untenable. In order to determine the role of the nephridia in osmotic regulation, the author has carefully estimated the osmotic pressure and the protein and chloride contents of blood, cœlomic fluid and urine, and has come to the conclusion that an earthworm, when submerged in water, can live like a fresh-water animal when both its gut and nephridia act as osmo-regulatory organs; but in the soil the earthworm lives like a terrestrial animal and the osmo-regulatory function adequately discharged by its nephridia alone, which reabsorb proteins and chlorides and conserve water. The mechanism of excretion has been clearly analysed into processes of filtration, reabsorption and chemical transformation. The significance of the phagocytic section of the nephridium has baffled many a previous worker, but Prof. Bahl, by making a spectroscopical examination of a solution of brownish excretory granules in pyridine, has conclusively proved that the colouring matter of these granules is the blood-pigment "hæmochromogen", and that the phagocytic section is really a "storage kidney" storing the destructive products of blood.

We might only add that not only has he obtained valuable results but that the technique he has devised for collecting adequate quantities of blood and urine is equally remarkable, as it was this difficulty which had so far made analyses of these fluids impossible.

S. L. HORA.

Hints for the amateur gardener

Each home presents a different problem in landscaping because of the individual preference of the owner. The following additional hints can be of great help.

The foundation planting should not hide the attractive features of the building. It should soften the hard lines. The lawn at places should come close to the building. It gives the effect that the building rests on the ground, not hangs on the foundation planting. It ties the building to the ground, which gives it a sense of stability and permanence.

Plant shrubs always in groups. A large variety of plants is not desi . They are likely to cause confusion. Few plant groups serve the purpose better. They give variation in foliage or bloom throughout the year. Plant of equal vigour should be used i groups so that they may be able to compete with each other successfully. In mixed planting of evergreen and deciduous plants, the former should be near the entrance to add refinement. The ascending plants cause confusion in the picture by their abundant and irregular growth. Their use should be made sparingly.

When planting near the foundation, one should make allowances for the plant growth. Straight lines in plantings should be avoided. The front lines of the shrubs should have smooth curves. Generally the replacement of the base plantings after eight to twelve years becomes necessary for an effective landscape.

Planting of trees in landscape has a double purpose. It is used for the landscpae effect. It also is used for the purpose of having shade and frui trees. This double purpose should al ways be kept in view, and all possibilities of combination of trees should be explored.

Formal gardens in landscaping can be designed to give pictures of definite shape. Radial and rectangular gardens are so designed and named. Some gardens are named after the material used. The rock garden is one of them. It is made by the accumulation of rocks on which grow certain plants. It gives an impression of a mountain. The continuous flow of a little water down hill would make it complete and effective.

Gardening, a pleasant hobby

These all essentials of landscaping pointed out above, if followed closely, would help an amateur to do away with an expensive expert advice needed to create a beautiful landscape. Gardening should become the hobby of every man. Only a small tract of land around the home is needed. The start be made with growing annuals. 1's fancy to create and grow things ld be awakened. We love flowers. We should also learn to love them in their natural surroundings for the beauties of their colours in the landscape. For the same reason we should love the plants also. Our affection for plants as well as for flowers should encourage the development of landscaping in India. It is very essential in a growing society because it contributes to the greater measure of happiness of each individual. It can provide recreational and educational opportunities, both for the children as well as for the adults. This is very essential for the healthy growth of a community. Landscape gardening, therefore, is a worthy programme and a noble profession which we should seriously follow for the happiness of homes.

ROLE OF FISHERIES FOR THE IMPROVEMENT OF NUTRITION OF THE INDIAN PEOPLE

By SUNDER LAL HORA

THE main principle affirmed by the Famine Inquiry Commission in their final report (Delhi: 1945) is that the State should recognize its ultimate responsibility to provide food for all. 'Within the last 100 years, Governments in India have accepted the duty to prevent widespread deaths from famine, but the further obligation of taking every possible step not only to prevent starvation, but to improve nutrition and create a healthy and vigorous population, has not yet been fully recognized and accepted.'

Present state of nutrition

After surveying the food problem of India as a whole, the Commission have suggested the lines of a food policy not only designed to prevent famine in future but to improve the diet of the people for a better standard of health. The Commission admit the existence of much ill-health, disease and mortality in India due to mal-nutrition. It is estimated that 30 per cent of the population in normal times does not get enough to eat, while the diet of a large proportion of the rest is unbalanced. Improvement of nutrition, therefore, must form an essential part of the public health programme in India. A well-balanced and satisfactory diet is, however, beyond the means of large sections of the people, and an improvement in the diet of the people cannot be achieved without a great increase in the production of protective foods and a simultaneous increase in the purchasing power of the people.

Fish, a readily available protective food

Milk, eggs, poultry, meat and fish are animal foods of high protective value. The Famine Inquiry Commission found that 'the average daily *per capita* consumption of milk in India has been variously estimated as 5.8 to 10 oz. though in most parts of India it is less than 4 oz. daily. To effect an increase in milk production, though highly desirable, is a long-range programme. The same is the position with regard to meat. No immediate increase in the meat supplies can be expected. In fact, due to the slaughter of a large number of cattle, goats and sheep to feed the Army, it will take sometime to replenish the stock. Efforts are being made to step up the production of eggs and poultry but this increase cannot offset the great demand for total protective foods. In view of these considerations, the Commission laid 'strong emphasis on an increased production of fish as a very important part of the programme for improving the diet of the population' and recommended:

> 'In India, where the *per capita* intake of meat and milk is small, fish has special importance as a supplement to ill-balanced cereal diets. The present supply of fish is totally inadequate; the development of fisheries is one of the most promising means of improving the diet of the people.'

The Commission were of the opinion that a great deal can be done immediately to increase the supply of fish and they recognized that 'an increased supply during the next few years is very desirable, in view of the present difficult food situation and the scarcity and high prices of protective foods generally.'

Fisheries and the Royal Commission on Agriculture in India

It is not the first time that such strong emphasis has been laid on the development of fisheries in India. The Royal Commission on Agriculture in India

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(p. 485, 1928), in commuting on 'Fish as an article of diet' observed:

'We have been struck with the comparative failure to develop the fisheries of the country as a source of food. We are aware that, in certain parts of the country, there are religious objections to the use of fish as an article of diet. But in Madras and Bengal, it is readily taken and much relished by some four-fifths of the total population. In Burma, it is universally liked and in the form of a fish paste (ngapi) is regarded as an indispensable condition. In Bombay, the United Provinces and Bihar and Orissa, large classes of the population take it when they can get it and, in the Punjab, there has been, since the war, a largely increased demand for it. Fish forms a specially valuable addition to a diet the staple of which is rice.'

After making various recommendations and pointing out that the development of inland fisheries should be regarded as one of the most urgent measures of rural amelioration, the Royal Commission on Agriculture in India concluded:

'Improvement in the cultivator's diet holds out such promise of improvement in his general health and the addition of fish to his diet impresses us as being so much the most promising way of providing it over large areas of the country, that we consider that we are more than justified in making recommendations which, to those who know the difficulties, may well appear to err somewhat on the side of optimism.'

The above recommendation of the Royal Commission with regard to the development of fisheries as early as 1928 seems to have had no effect on the authorities concerned till the Bengal Famine of 1943 brought once again to light the precipice on which the Indian people stand so far as nutrition is concerned.

Estimate of fish requirements

It will thus be seen that there is an urgent necessity of developing the much-neglected fishery resources of India in order to attain a better standard of nutrition and health. Calculating on the basis of 100 grams of dry protein per head per day, of which 50 grams should be first class protein of animal origin (milk, eggs, mat, poultry or fish), it is calculated by nutritional experts that proportionately 23 seers (one seer =approx. 2 lb.) of fish is needed by a person per annum. Against this individual requirement, and taking into consideration the huge population of India, the present marketable production of two crore maunds of fish seems extremely insiginficant. The Government of India have fixed a target of increased production at 300 per cent though according to the needs and requirements of the people it should be about 10 to 12 times more than the present production.

Role of marine and inland fisheries

Though India is rich both in its marine as well as in its inland fisheries, the latter are of greater importance in feeding the poor. Under the existing conditions, marine fish are distributed in a fresh state within a distance of 20 to 30 miles, while the bulk of the catches are cured and dried for export as the product is of an inferior quality. In the development of Indian fisheries, therefore, it should always be borne in mind that India's millions live far away from the sea. India has vast inland fishery resources, the climate is tropical, the people are illiterate and ignorant, the general standard of living is low and the means of communication are extremely poor. Under these circumstancs, a rapid extension of freshwater carp culture is the most hopeful way of tackling the urgent problem of increased fish supplies. In the proper utilization of the village pond, therefore, we find ideal conditions for the feeding of the poor with a nutritive diet and for raising his standard of living; the two objectives which the Famine Inquiry Commission have suggested should be the food policy of the Government of India.

BUILDING UP OF DISEASE-FREE STOCKS OF SEED POTATOES

By R. SAHAI VASUDEVA

POTATO is the most extensively cultivated of all vegetables in India. It is produced abundantly in other countries and its production exceeds that of wheat and rice combined. The area under potatoes in India is much smaller in comparison to other countries and is estimated at less than one per cent of the world acreage. The quantity produced in this country is highly insufficient as India was importing before the war potatoes worth about thirty lakhs of rupees from other countries so much so that certain parts were almost wholly dependent on foreign potatoes. The war resulted in complete closing down of what were previously large importations of seed potatoes from foreign countries. We had to meet an ever-increasing demand of seed potatoes from India and had even to find new sources of material.

A regular flow of potatoes for table purposes cannot be kept up without a constant source of seed potatoes of high quality and some system of maintaining freedom from disease on a large scale so that deterioration does not exceed the rate at which healthy material can be distributed.

On an average about 109 maunds of potatoes per acre are produced in India as against 224 maunds in Belgium and 183 maunds in the United Kingdom. Comparing with the other important potato-growing countries of the world the yield per acre in India stands at the bottom.

The poor yield in India is mainly due to the poor quality of seed. It has been observed by the farmers who have for generations been cultivating this crop that the stocks of potatoes always deteriorate when continuously grown in their land for several years and that change of the seed stock is necessary because it always yields vigorous crop. This knowledge of changing the seed stock is based on the fact that the farmers obtain greater produce from fresh seed than that from old stocks. A large number of cultivators are still ignorant about the real cause of the degeneration of seed potatoes and believe that change of seed is the only solution for all potato maladies.

Virus diseases as cause of deterioration

It has been determined in India as in other countries that the degeneration of seed potatoes is not due to environmental conditions but is caused chiefly by certain group of maladies known as virus diseases. These diseases are prevalent wherever potatoes are cultivated and cause huge losses in yield every year. So far the cultivators in India are unaware of these diseases though in progressive countries knowledge of virus diseases has spread among the potato-growers and they are taking necessary precautions to keep them under control.

In England the annual loss due to virus diseases is more than 66 thousand bushels while in 1926-27 in the United States of America the losses were 8 to 14 million bushels. In India so far no estimate has been made of the losses due to virus diseases but survey of these diseases in the hills and plains of India has clearly shown that majority of the plants are infected with virus diseases and in certain fields infection to the extent of 100 per cent has been observed. The infected seed material is used year after year and the disease in the crop goes on multiplying. Once a plant gets infected it is difficult to eradicate the disease. The produce of such plants will give diseased tubers which if planted again will result in diseased crop. Un-

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AGRICULTURE, ANIMAL HUSBANDRY AND FISHERIES AS CORRELATED INDUSTRIES

By SUNDER LAL HORA

SINCE the Bengal Famine of 1943 and the consequent ravages wrought by pestilence and disease, it has come to be realized that besides the obligation to take every possible step to prevent starvation, each civilized Government must also try to improve nutrition in order to create a healthy and vigorous population. In the case of India it has become abundantly clear that, in view of the present difficult food situation and the scarcity and high price of protective foods generally, an increased supply of fish during the next few years is very desirable. It will be readily conceded that a rapid extension of freshwater carp culture is the most hopeful way of tackling the urgent problem of increased protein supplies. It must be further realized that India's millions live far away from the sea, India has vast inland fishery resources, the climate is tropical, the people are illiterate and ignorant, the general standard of living is low and the means of communication are extremely poor.

The object of this note is to show that besides increasing the production of fish, a village pond, properly utilized, can be an asset of no mean value for agriculture and animal husbandry. I shall take a few instances to illustrate this point.

Paddy cultivation and fish culture

'In Japan it is customary in suitable localities to place young carp, when 1 or 2 in. long, in the paddy-fields in June when irrigation begins; by October, say four clear months, when the paddy is cut these have grown to 8 or 10 in. and are quite marketable; the rapidity of growth is due to the warmth, excellent feeding on minute crustaceæ such as copepods, larvæ, etc. in the fields, from which, of course, they are kept from escaping by bamboo gratings. Should the water in fields fall, the ryot digs a small pit in one corner in which the fish can survive till more water comes down. The rearing of the fish in the fields is said to improve the produce of the paddy since the fish destroy many insects injurious to the plant[1].

This practice is common in China also where fish are used for the control of paddy stem-borers. It is estimated that besides an additional harvest of fish, the yield of paddy is increased by about 10 per cent.

Since 1943, Bengal has also carried out experiments with paddy-cum-fish culture in the embanked, rain-fed and extensive paddy-fields of the *Abad* areas of the 24-Parganas (Sunderban estuary of the Ganges) with marked success. Several individuals and companies have now adopted this measure on an extensive scale and the Government encourages small farmers by supplying carp fry *gratis*. Mitter[2] calculated that if the acreage in Bengal under rice and jute be utilized for the culture of fish simultaneously with these crops and if the average yield from the fishery be calculated at a modest of Rs. 10 per acre, an annual income of nearly five crores of

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[1] Nicholson, F. Notes on Fisheries in Japan. *Bull. Madras Fish Deptt.*, 2. p. 86 (1907).
[2] Mitter, S. C. *A Recovery Plan for Bengal.* P. 243, (Calcutta, 1934).

could be derived from this by-product alone leaving aside the additional income through the increased production of paddy.

Reclamation of low lands and fish culture

In all countries there is a considerable acreage of marshy, unproductive lands where food crops cannot be grown. The most economic method of reclaiming such areas is the excavation of a large tank round the lowest part and filling up the neighbouring plots with the earth obtained from excavation. On a small scale, every villager in Bengal adopts this method for raising the plinth of a piece of land on which he will build his house. The Calcutta Improvement Trust improved the southern portion of Calcutta by the excavation of the Dhakuria Lake. There are several other similar projects for the improvement of other parts of Calcutta.

In rural areas, agricultural lands have been similarly improved and paddy and fish grown together. In one instance, known to the writer, the capital outlay in carrying out the project was recovered in the very first year by the sale of extra paddy grown in that area and the entire crop of fish of several maunds was a clear gain.

Premature reclamation of low-lying areas by the construction of embankments to check the inflow of saline tidal waters has proved to be a great curse for Bengal, since by restricting the spill area of a tidal creek its bed became raised and the neighbouring low-lying, reclaimed lands lost their drainage artery. The best method of reclaiming low land adjacent to a tidal creek is to convert it into a fishery by putting up suitable embankments and sluices, so that silt-laden waters carrying eggs and fry of fish can gain access to this low land. Gradually, through the deposition of silt, the bed of the fishery will be raised in a few years' time and the land will ultimately become suitable for paddy cultivation. In the meantime the waste land will annually yield very profitable fish crops. It is a matter of great pleasure to state that in the Sunderbans *Abad* areas of Bengal, particularly in 24-Parganas, several landholders have adopted this suggestion for the improvement of their property and have derived great benefit therefrom.

Tank irrigation and fish culture

It is a wrong and popular belief that only permanent pieces of water are suitable for fish-culture, for it has been established that nothing decreases the fish production of a tank so largely and rapidly as continual immersion of its bottom. The productivity of a tank is usually increased if we occasionally dry it out completely and allow it to lie fallow for some time. This fish cultural practice, therefore, stands in close relation to irrigation as has been stated that 'among the measures that may be adopted for increasing the area under cultivation, the first place must be assigned to works for the supply and conservation of waters, the importance of irrigation from small tanks or village ponds for purpose of agriculture and fish culture will, therefore, be fully realized. In fact, the Famine Inquiry Commission regarded the 'development of irrigation from private works as at least equal in importance to that of irrigation from works constructed by Government'.

Tanks in many parts of India form an important source of irrigation but there is considerable scope for improving agriculture by utilizing comparatively smaller accummulations of water for irrigating vegetable gardens or fodder crops for cattle during the dry season. Irrigation works will not only benefit agriculture but will be a boon to the fish farmer who wants to dewater the tank for the eradication of predatory fishes and for the proper fertilizing of the pond bottom. It will thus be seen that tank irrigation is not at all antagonistic to fish culture but is equally beneficial for agriculture and pisciculture.

In the case of seasonal tanks or tanks that can be drained for irrigation or other purposes, it is highly desirable to cultivate a short-term crop on their beds. Besides

getting a good agricultural crop in such circumstances, this practice helps in the eradication of predatory fishes and in fertilizing the pond. If a leguminous crop could be raised, it would prove extremely beneficial for the growth of fish in the tank. Green manuring of the pond's bottom is helpful for the growth of fish.

The bottom silt of a fish pond is a very good fertilizer for land crops and is readily sought by the cultivators of Western Bengal. The practice of removing bottom silt from canal beds is very common in China where it is extensively used for the preparation of compost manure.

It will thus be seen that fish culture in paddy or jute fields, in tanks excavated for the improvement of agricultural lands and in irrigation tanks, are important links which could effect close correlation between agriculture and pisciculture.

Cattle farming and fish culture

The success of carp culture in central Europe, Japan and China depends on the fact that carp ponds receive a copious supply of stable or farmyard manure drained direct into the pond, besides other organic and chemical manure. It is commonly found that a village pond frequented by cattle, or with cattle-sheds by its side, shows a remarkable growth of fish as compared with other ponds not so situated. If the tank water is used for irrigating fodder crops, then there will be a distinct improvement in the health of the cattle. This is particularly true in Bengal, where, for lack of fodder, every dry season the cattle become emaciated. Proper utilization of farmyard manure for fertilizing fish ponds and the utilization of fish ponds for irrigating fodder crop could be of great mutual benefit to fish culture and animal husbandry.

A question has been asked as to how ponds fertilized with farmyard or stable manure can be used as a source of drinking water for animals? Properly maintained fish ponds, however heavily manured, are generally more sanitary than ordinary neglected village ponds which at present serve as the source of drinking water for the cattle. Further, cattle are believed to be immune from ordinary water-borne diseases, but I am not in a position to express an opinion on this point.

Duck-farming and fish culture

Duck-rearing is a profitable cottage industry and the owner of a tank, besides rearing fish in it, growing vegetables and fruits on its sides, irrigating his land for double cropping, can also use it for duck rearing with advantage to the fishery of the tank. Ducks will control excess vegetation, feed on insects, snails and bibalbes and fertilize the water with their excreta of great manurial value.

A village pond

At present, the average village pond is in an insanitary condition and almost neglected. With a few laudable exceptions, fish culture is done in some of them in a very primitive way. In the light of what is stated above, it will be clear that a village pond can be made the centre, on a small scale, of all kinds of food industries. Another advantage of pond culture will be that the tanks will become sanitary and, instead of being an eye sore and a menace to public health, they will become the most valuable assets of the village community as store-houses of a food of high nutritive value. In any scheme of mixed farming, particularly in areas similar to those of Bengal, it will be well to bear in mind that fish-farming can provide the nucleus for other food industries. In view of what is stated above, it seems imperative that more attention should be paid to the economy of a village pond and coordinated investigations should be conducted to evaluate quantitatively the benefits to each industry.

In view of the fact that an average village pond is at present very much neglected and that it can be utilized for fish culture, irrigation and duck-rearing, it is suggested that coordinated investigations should be conducted into the utility of village ponds in rural economy of India.

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FISHERIES RESOURCES OF WESTERN BENGAL AND THEIR UTILIZATION

SUNDER LAL HORA

ZOOLOGICAL SURVEY OF INDIA, INDIAN MUSEUM, CALCUTTA

The *Report on the Markting of Fish in India*, published, in 1946, contains data of fish production for 1937-38. In that year, the estimated production of sea-fish in Bengal was 17.20 lakhs of maunds valued at 34.6 lakhs of Rupees. The estimated surplus of freshwater fish was then 31,332 lakhs of maunds valued at 432.92 lakhs of Rupees. The *Report on the Marketing of Fish in the Indian Union*, now under preparation, gives the estimated production of sea-fish in Western Bengal as 5.772 lakhs of maunds valued at 85.3 lakhs of Rupees. The estimated marketable surplus of fresh water fish is 11.973 lakhs of maunds valued at 335.7 lakhs of Rupees. If we leave out of consideration all activities regarding grow more fish during the last decade, even then it will be found that 67.2% of the sea-fish production and 62.0% of the surplus freshwater fish production of Bengal have gone to the share of East Bengal! Though on the population basis (West Bengal 21,196,453; East Bengal: 41,949,710. Census 1941), this division of fisheries seems justifiable, it must be remembered that West Bengal is the most industrialized part of the Union of India and contains within its limits the city of Calcutta, a problem by itself so far as food requirements are concerned. Moreover, people of East Bengal eat quite a lot of fresh fish at source which does not come to the market and is not recorded in the above figures.

From the figures of fish production and its value given above, the following further facts can be adduced:

1. The freshwater fisheries resources were far more valuable in Bengal, for they contributed 50.1% of the total production in India. West Bengal even now leads the rest of the Provinces and States in the Indian Union with 28.97% of the total freshwater fish production.

2. In 1937-38, the average price of sea-fish was Rs. 2|- per maund and that of freshwater fish Rs. 13.8 per maund. In 1948, they had arisen to Rs. 14.7 and Rs. 28|- per maund respectively.

3. The high price and production of freshwater fish indicate preference of the people for freshwater fish but, during the last decade, there has been a marked improvement in the demand for sea-fish as the ratios of sea-fish and freshwater fish prices in 1937-38 and 1948 (2: 14.7 and 13.8: 28) would indicate.

These important factual data must be borne in mind in considering the fisheries resources of Western Bengal and their utilization. As fisheries is a natural resource, we may first briefly consider the nature of the country where the resources are located.

* Talk given at the Discussion Meeting of the Royal Asiatic Society of Bengal on March 1949.

Physical Basis of the Fisheries Resources of Western Bengal

Bengal is a deltaic province and is, therefore, a low-lying part of India. There are, in consequence many depressions and marshes in the lower parts and owing to fairly high rainfall they remain filled with water permanently or seasonally. In the upper parts, owing to set monsoon seasons, water is stored in ponds for domestic and agricultural purposes, so the province is dotted over with innumerable collections of impounded water of varying sizes. The rivers of Bengal carry large amount of silt and are, therefore, liable to change their courses very frequently, with the result that innumerable *bheels* are formed in the beds of dead rivers. There had been a general tendency for the rivers in Bengal to oscillate from west to east. Extensive estuaries are formed by the Ganges and the Brahmaputra, which are almost uninhabited for the greater part of the year. There are no suitable harbours on the coast of Bengal and, the silt carried down by the rivers sometimes forms bars at their mouths which render navigation hazardous even during the calm season. The bottom is muddy and soft over a greater part of the estuaries and foreshore and the continental shelf round India, particularly round the Bay of Bengal, is very narrow. The detritus carried down by the rivers fertilizes the water and the tropical temperature is conducive to fish growth.

As will be clear from the above account, the living rivers are now in East Bengal and in consequence the riverine, estuarine and foreshore fisheries are more productive in that Province. In West Bengal, the salinity in the estuaries is high and most of the rivers and creeks are strongly embanked in the interest of agricultural crops. There is more emphasis on paddy cultivation than fish production in the Sundarban *Abads*. The western part of West Bengal comprises dry districts, where large irrigation tanks had been constructed in the past and need for canal irrigation is being strongly felt now. The rivers are being dammed for the storage of water for multiple uses.

Resources and their Utilization

We can now examine the fisheries resources of Western Bengal against the background of the preferences of the people, the topography of the country and the basic peasant economy of its inhabitants. It will be admitted on all hands that an average Bengali would prefer *Rohi Machh* (*Labeo rohita*) to *Bhetki* (*Lates calcarifer*) at any time and for this reason on ceremonial occasions *Rohi* rather than *Bhetki* is in great demand. The topography of the country and the peasant economy of its inhabitants are also more suitable for freshwater fish production and I have no doubt that, if increased fish production is measured in terms of the money spent on various schemes all over India, it will be seen that a comparatively much smaller investment in inland fisheries has yielded very encouraging results. Inland fisheries are of various kinds and each type will now be considered separately.

Pond Culture. Of all the freshwater fisheries resources of W. Bengal, ponds provide a wealth, which is still greatly under-developed, in spite of the fact that in starting the Fisheries Department in 1942, the Government of Bengal laid down pond culture as its main objective. So far as the scientific side of this development is concerned, Bengal has already been recognized as the leading exponent of this resource utilization. Unfortunately, administrative difficulties in harnessing very fully this resource have not yet been overcome. A large number of ponds are still lying in a derelict condition. Shallow ponds and *bheels,* which could be more profitably used as fisheries, are being reclaimed

prematurely for agricultural purposes. Water-hyacinth is still being permitted to extend into clean fisheries.

I am given to understand that the "Rural Pisciculture Scheme", started by me in 1944, has been considerably extended. According to this scheme, fish-seed was supplied at a subsidized rate to owners of tanks who undertook pond-culture on proper scientific basis. The operation of the Scheme also made it possible to impart necessary technical information to fish farmers, to demonstrate scientific methods of production, harvesting and utilization of fish crop and to offer the services of a small band of technically trained pond culturists at a nominal charge to pond owners requiring services of skilled personnel.

The pond cultural practices of Bengal have succeeded in certain farms in producing 2,000 lbs. of fish per annum, a food crop yield of high class protein much greater than that can be affected by agricultural practices. It is probable, however, that by following Chinese methods, which yield 4,000 to 5000 lbs.|care| annum, further improvements can be effected. There are large areas in which the practices employed do not reach a satisfactory level and in addition there are even large areas in which practically no use is made of the available bodies of impounded water. The fullest possible development of these resources is desirable for the long-range programme of meeting food-requirements and steps to this end are most urgently required in the present state of West Bengal's fish supplies. Apart from its rôle in food production, a programme for development of pond-culture is of deep significance in relation to peasant economy, its intimate physical relation to the structure of the village, the lower level of capitalization involved and its dependence on the human element. There are three major programmes under pond culture which deserve particular attention in West Bengal and to these I shall now refer.

1. Paddy-*cum*-Fish Culture

I have already referred to the embanked condition of the paddy fields in the *Abad* areas of the Sundarbans in the district of 24-Parganas. Simultaneously with the paddy crop, a fish crop of 100 to 300 lbs.|acre is usually harvested in suitable areas, but the supply from paddyfields can be augmented several folds through proper cultural methods. In China, fish-breeding in paddy fields is used for effectively controlling the most serious insect-pest, the stem borer. The yields have thus been noticed to have increased by about 10-15%. Furthermore, there are clear indications of fish eating mosquito larvæ and thereby preventing the spread of malaria. In the Dutch East Indies, fish-culture in paddy-fields has been characterized "as the highest form of pisciculture" and a higher yield of rice to the extent of 5-15% has been reported. Small scale experiments conducted by the Directorate of Fisheries, Bengal, during 1945-46, showed an increased yield of paddy by 150 lbs.|acre. The FAO Rice Conference at Baguio, in March 1948, recommended the adoption of this practice in all suitable areas. Unfortunately some critics wanted all fish of 9″ to 12″, harvested from paddy-fields, to be grown further in ponds. Those who have some idea of the paddy-fields in the Sundarban *Abads* know that this is not practicable in each and every case and who among us will say that a *Rohi* or a *Catla* (*Catla catla*) or a *Mrigal* (*Cirrhina mrigala*) a foot in length is to be despised as food. I feel convinced that this extensive resource of West Bengal is capable of great expansion for the increased production of both cereals and fish.

2. *Bhasa-badha* OR POND CULTURE OF BRACKISH-WATER FISHES

Long ago, Sir K. G. Gupta in his reports on the Fisheries of Bengal hinted at the boundless possibilities of increasing fish supply from the estuarine areas by "improving and extending the system of *bheris*" which, before the Bidhyadhari river became defunct, was found so profitable in the Salt Lakes area in the neighbourhood of Calcutta. During my period of service in Bengal, a few fisheries of this type were started and some derelict ones were repaired, but the terms of the leases of land in most promising places were such that the land could only be used for paddy cultivation but not for fish culture. In spite of the best efforts of the Directorate of Fisheries, it was difficult to persuade the District Magistrates to relax the lease clauses, and in the interest of grow more fish, to allow the low-lying unproductive areas to be used for raising fish crops If such administrative difficulties could be overcome, I have not the least doubt that it will be possible to bring under pisciculture vast areas adjoining rivers and creeks in the Sundarbans. There can be no better way of reclaiming low lands in these parts even for agricultural crops than through the operation of the system of *bheris* for fish culture.

3. SEWAGE IRRIGATED FISHERIES

The Salt Lakes of Calcutta are no longer used as salt-water *bheris* but are now cut up into extensive freshwater fish-farms. They are shallow and would normally dry up during the hot months but fortunately the Sewage Outfall Channel of the Calcutta Corporation passes through the Salt Lakes area. The greatly diluted Calcutta sewage is taken into a number of fisheries and the results of carp production in them are very profitable. If arrangements could be made with the Corporation of Calcutta for a proper distribution of the sewage water to these fisheries, the production in this 70 square miles area will go a long way to meet the requirements of Calcutta during March to June when fish from other sources is normally scarce in the markets. I worked hard and planned the development of this area as a fishery but unfortunately H.E. Mr. R. G. Casey, Governor of Bengal, who took great interst in the Scheme, left Bengal and since then little attention seems to have been paid to this most productive scheme. A public company floated for the reclamation of this area, under the combined auspices of the Government and the Corporation, will convert it into a health resort for the over-congested town and would produce large quantities of wholesome *pona* (carp) fish. The advantage of developing this area is that problems of refrigeration and transport do not arise, for with little effort fish can be sold alive in Calcutta even during the hottest months.

Before leaving the subject of Pond Culture, I with to emphasize once again that the programme of Pond Culture in Western Bengal and the proper utilization of all our resources in this line will give an immediate relief in meeting fish shortages.

Bheel Fisheries. Closely allied to pond culture, is the utilization of *bheel* fisheries. They have been greatly neglected and overgrown with thick vegetation and now it has become difficult for individuals to reclaim them. I admit that methods of reclaiming them are not yet fully understood and, therefore, experimentation and research are called for. We have been considering development of *bheel* fisheries for at least four or five years but no beginning has so far been made. Once the Government can demonstrate a successful method of working *bheel* fisheries, I have no doubt private enterprises will not be lacking to utilize this resource for the production of fish.

Riverine Fisheries.—There are only a few small rivers which in their entirety belong to Western Bengal. Proper conservation of fisheries of these must be planned on a scientific basis. Some of them are shortly going to have dams and wiers which will have considerable effect on their fisheries. The rivers are the main source of fish-seed supply and if their fisheries are interfered without making adequate provisions for the breeding of fish, besides deterioration in river fisheries, pond-cultural activities will be seriously affected.

The rivers which are common to several provinces of the Indian Union and East Bengal can only be developed on a federal or international basis. These rivers must be nationalized and suitable fishery conservation measures adopted.

Estuarine Fisheries.—The only estuarine areas of W. Bengal are those located within the Basirhat and Namkhana Ranges of the 24-Parganas. Unfortunately, they were not of very great importance in Bengal and I did not survey them properly. For the development of these fisheries, refrigeration and quick transport are two most essential requisites and it is gratifying to note that the provincial budget for 1949-50 contains a provision for the supply of power craft to the existing trade for quick transport of fish. I have not seen the scheme but presume that equal attention has been paid to the supply of ice for refrigeration purposes.

Fore-shore Fisheries.—The chief centres of marine fisheries in W. Bengal are the Moore and Fraserganj Islands near the mouth of the Hooghly in the 24-Parganas and the Contai Coast with principle fishing centres at Jalda, Samdraput, Junput and Kalagachit. I have not personally studied the fisheries of the Moore and Fraserganj Islands, but if they are comparable in any way to those of the Dubla Island at the mouth of the Passur River, then the following development measures for their fuller utilization can be suggested.

1. Arrangement for refrigeration, crushed ice in the first instance, and quick transport of quality fish for the Calcutta market.

2. Improvement in the methods of fish processing by the introduction of salt-curing, drying on raised platforms, etc.

3. Utilization of waste fish and fish-wastes in developing by-product industries on the spot.

As regards marine fisheries of the Contai Coast, I am fairly well familiar with them and would suggest the following phased programme for their development :

Phase 1.—Improvement of the existing fishing methods by the supply of fishermen consumer goods ; towing out boats to the fishing grounds ; use of "Ducks" for landing catches ; supply of ice in sufficient quantities ; grading of fish ; ensuring utilization of quality fish for table either locally or in the Kharagpur and Calcutta Markets ; salt-curing of smaller fish ; utilization of fish wastes and waste fish for the manufacture of fish meal or manure and the utilization of shark-livers for the manufacture of oil.

Phase 2.—Introduction of larger power vessels as tugs and mother vessels, for taking out fishing boats beyond the limits of inshore fisheries; development of fishery Co-operatives and provision of up-to-date marketing facilities for fresh and dried fish and other fishery products.

Phase 3.—Employment of small power fishing vessels in conjunction with mother or factory ships, the latter for the treatment of the produce on the spot,

for the safety of the fishermen and for enabling fishermen to stay away their home for some days.

Phase 4.—Deep-sea fishing with drift and seine nets, trolling (not trawling) and long-line fishing.

I cannot say how long will each phase last, because that will largely depend on the administrative ability of the personnel and the knowledge, earnestness and industry of the technical staff employed. Of one thing I am certain in my mind that evolutionary changes, as represented in the above phased programme, will have far more chances of success in the background of the economy of the operatives and the preferences of the people than any revolutionary innovations. Short circuiting of the evolutionary programme may be possible within limits but any marked deviation may result in serious failures.

Fish Supply Problems

The fisheries resources of Western Bengal, though perhaps inadequate for the needs of its people, are fairly varied and extensive and are capable of great expansion through well-planned economic development schemes. At the very outset, it must be borne in mind that the fish supply problems of West Bengal are twofold. Calcutta and the neighbouring industrial areas with high purchasing power and rural Bengal with peasant economy and very low purchasing power. We shall not be serving Bengal faithfully unless we bear in mind both the problems simultaneously. I am, however, aware that the solution of the Calcutta problem may solve to some extent the problem of supply to rural Bengal as a sequence thereof.

Calcutta and the industrial centres in the neighbourhood are cosmopolitan in regard to the composition of their population and generally speaking their inhabitants are less conservative, more literate and hold progressive ideas. Through a well-organized marketing propaganda many innovations can be introduced in these areas. On the other hand, the rural population is very conservative, particularly in the matter of food, less literate and backward so far as modern developments are concerned. The utilization of fishery resources must be planned against this background.

Leaving alone for the time being the heavy fish imports from East Bengal and the neighbouring provinces of the Indian Union, the fish supply position of Calcutta can be improved by the utilization of the Salt Lakes fisheries, *bhasa-badha* and paddy-field fisheries of the Sundarbans, development of estuarine and foreshore fisheries and the utilization of the *Bheels*. Pending these local development, which may take some time, Calcutta should import fish in ice or refrigerated holds from the West Coast by arrangements with the Government of Travancore, Cochin and Madras. All quality-fish production along the West Coast, after meeting local requirements, should be brought to Calcutta. I was greatly surprised that in the Hong Kong markets, the cheapest fish was the Canadian Herring or *Hilsa*. If currency restrictions can be overcome, I would certainly like to see Calcutta markets flooded with Canadian *Hilsa*. Now Calcutta and other industrial centres are feeding on the rural areas where the supply is already inadequate with the result that, in the absence of any other high quality body-building and protective food, ill health and misery are the lot of the rural population.

So far as the rural areas are concerned, the proper development of inland fisheries, particularly pond culture, holds the most brilliant prospects. Providence made Bengal a country full of tanks, ponds and *bheels* and made its people relish pond fish in preference to other varieties. It should, therefore, be the duty of the administrators and servants of the country to fully utilize the local resources and to cater for the preferences of the people.

During my period of office in Bengal, four departments, besides the Directorate of Fisheries, were looking after the various aspects of the Provincial fisheries, namely (*i*) Revenue Department, which provided funds for the rehabilitation of fishermen and improvement of tanks, looked after the management of *Khas-Mahal* fisheries, and settled legal aspects of the utilization of land (paddy cultivation or fish culture), etc., (*ii*) Industries Department helped in the procurement and distribution of fishermen consumer goods, (*iii*) Co-operative Department, worked among fishermen to organize them into effective units for production and marketing of fish and distribution of consumer goods and (*iv*) Irrigation Department, that owned a large number of canal and *bheel* fisheries, looked after the sale of fishery rights in the waterways of the province. Though for fish supplies, the Directorate of Fisheries was always held responsible for all acts of omission and commission, the position behind the scenes was lack of proper perspective and co-ordination between the various Departments of the same Government, with the result that much energy was dissipated in commonplace bickerings and very little came out of the pooled resources of all these Departments. While attending Departmental Committees and Conferences, I was always reminded of the dictum of the late Dr. N. Annandale. He was of the opinion that the wisdom of a Committee is less than that of its least intelligent member. We all know by now that compromises have never paved the way to any big success but only help to postpone decisions on matters of vital importance. I do sincerely hope that, with the advent of peoples' Government, these are things of the past, though I have my apprehensions because prejudices and jealousies take a long time for their eradication. The first bottle-neck for the proper utilization of fishery resources is, therefore, lack of co-ordination and so long as officials do not give up "Departmental views" and learn to face the problems as a whole, much progress cannot be made.

For any development plan, there are three essential requisites *i.e.*, Men, Material and Money. These essentials are arranged in order of priority. Are there suitably qualified men available in the province for taking charge of development plans? So far as I am aware, they are very few. It is obvious, therefore, that training of personnel is priority No. 1 in our plans of fisheries development. I must make it clear here that for developing natural resources, outside experts can be of little value and that experience of persons with knowledge of local conditions is most essential. Unless we have practical men on the scene, the question of material required for our development plans does not arise, as investments made in materials in the absence of knowledgable persons to use them can be written off straight away. The question of money, to which highest priority is given at present, is of very minor importance. When you have practical men who know precisely what equipment is required, the results are bound to be encouraging right from the beginning and the public will not then hesitate to invest in fisheries development. Most of the major schemes would be taken up a Public Liability Concerns, partly with Government funds and partly with public funds. Taking everything into consideration, the second bottle-neck is the lack of trained and experienced personnel.

In my opinion, a lasting and nation-wide development of fisheries in Western Bengal must be a slow and gradual process of the evolutionary type, in which training and experience of the personnel actually engaged in research and development will be our greatest assets. Any hurried, spectacular measures, such as trawling experiment of the "Golden Crown" or training of students in American Shad Fisheries and Central European Carp-Culture Industry, are bound to fail as they had already failed not in the very distant past. Large schemes designed to bring the produce of the seas into Indian markets and to habituate the people to eat unfamiliar fishes will take years to complete. From the short term point of view, it is necessary to carry out a large number of smaller, less ambitious, but economically sound projects which will in the aggregate increase production considerably. It is extremely unfortunate that while big schemes are being readily financed, adequate money for smaller, but highly productive schemes, is usually not forthcoming. This mental outlook with regard to the financing of schemes is the third bottle-neck to be tackled.

Conclusion

In conclusion, may I quote the concluding paragraph of Sir P. M. Khareghat's communication to the *Times of India, Bombay,* dated 14-2-49, on "Failure of Food Drive," wherein he stated:

> "In short agricultural production can only be increased if a number of different measures are adopted with energy and the necessary requisites for carrying them out are made available by Government of India. There is no magic wand that can be waved for increasing output. It will not be achieved merely by talking and planning. It will entail hard and laborious work by the agriculturists and by those who have to guide them. It will require a large expenditure of money and materials. It will need a far-sighted policy by Government, giving security to the producer to ensure his whole-hearted co-operation and joint working by all the departments of the Government concerned. Food production has not increased because these requisites have not been available. It is now up to Government to make them available. Will they do so?"

The same applies *pari passu* to fisheries production in Western Bengal. Our valuable resources, in spite of talking and planning for years, still wait utilization to feed the common man so as to raise his nutritional standard and to make him healthy and strong.

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DEVELOPMENT OF FISHERIES IN INDIA

By

SUNDER LAL HORA

D.Sc., F.Z.S., F.R.S.E., F.N.I., F.R.A.S.B.

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DEVELOPMENT OF FISHERIES IN INDIA.

Views of Specialists.

Edited and Collated

By SUNDER LAL HORA, D.Sc., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I.,
Director, Zoological Survey of India, Benares Cantt.

CONTENTS.

FOREWORD.

Though my interest in the fish and fisheries of India was aroused as early as 1917, when as a student of the M.Sc. class at Lahore (Punjab University) I was asked by Dr. R. H. Whitehouse to make a preliminary study of the 'Fish Fauna of Lahore',[1] it was not until I joined the Zoological Survey of India in 1919 that I had an opportunity of receiving training, from the late Dr. N. Annandale, in methods of field investigation of fisheries of a given area and in studying the ecology, bionomics and systematics of different groups of fishes. My first published article on 'The Fish of Seistan'[2] was in collaboration with Annandale who, in an appendix, described the fisheries of the delta of the Helmand and the use of shaped rafts of bulrushes in India and Seistan. When entrusting me with a zoological survey of the Manipur Valley in February-March 1920, Annandale gave me a copy of his article on 'Fish and Fisheries of the Inlé Lake'[3] and wanted me to prepare a similar report with regard to the fish and fisheries of Manipur. Annandale visited the Valley for a week or so but during this brief period I learnt

[1] The results of this study were embodied in a dissertation submitted to the Punjab University in the fulfilment of the then existing regulations for the M.Sc. degree. The dissertation not only contained descriptions of the species recorded from Greater Lahore, but an account of the methods of fishing and marketing with observations on the improvement of fisheries. A list of 42 species recorded in this work was recently published by Nazir Ahmed in his 'Fishes of Lahore' (*Bull. Dept. Zool. Punjab Univ. I*, p. 255, 1943).

[2] Annandale, N. and Hora, S. L.—*Rec. Ind. Mus.*, XVIII, pp. 151–203, pls. XV–XVII (1919).

[3] Annandale, N.—*Rec. Ind. Mus.*, XIV, pp. 33–64, pls. I–VIII (1918).

much from him which it is difficult to express in writing. The results of my survey are embodied in an account of the 'Fish and Fisheries of Manipur with some observations on those of the Naga Hills'.[1] Though later, as an Officer-in-Charge of the Cold Blooded Vertebrate Collections in the Zoological Survey of India (Indian Museum, Calcutta) I was mainly concerned with systematic work on Indian fishes, the fascinating study of Indian fisheries was never lost sight of. Several articles on the customs and habits of fishermen, methods of catching fish and on the bionomics and migrations of important food fishes were published from time to time when I was still serving in the Zoological Survey of India. From among such contributions, reference may be made to 'Mud-fishing in Lower Bengal',[2] 'Trade in Live-fish (Jiol Machh) in Calcutta',[3] 'Crab-fishing at Uttarbhag, Lower Bengal',[4] 'Wanderings of the Bombay-Duck, *Harpodon nehereus* (Ham.) in Indian Waters',[5] and a series of articles on the spawning grounds and bionomics of *Hilsa* summarized in 'Life-history and Wanderings of *Hilsa* in Bengal Waters'.[6] The series of articles on the 'Game Fishes of India' published in the Journal of the Bombay Natural History Society contains information which could be made use of by fishery scientists.

In the meetings of the Fish Committee of the Imperial (now Indian) Council of Agricultural Research, among other things, I had directed attention to the construction of dams and weirs and its effect on the fisheries of the migratory species, the pollution of streams by municipal and factory effluents and its harmful effects on natural fisheries, the preservation of fish for its proper utilization and the need for a Central Institute of Fisheries Research.

Besides contributing articles myself on Indian fisheries and raising discussions on important aspects of fisheries development from a purely scientific point of view, I requested specialists with practical experience of Indian fisheries problems to contribute notes regarding Indian fisheries. Of these, two articles by Dr. J. T. Jenkins on 'The Fisheries of India' [7] and 'The Fisheries of Bengal—Can they be improved and developed' [8] and two articles by Dr. Albert W. Herre on 'Lessons from the Fish Markets of Calcutta' [9] and 'The Fisheries Departments of the Philippines and Malay with Comments on the needs of Bengal and India' [10] are of particular interest.

Though I was thus equipped with considerable knowledge of the scientific problems of fisheries development in India, on taking over charge of the Fisheries Department in Bengal in May, 1942, I found myself lacking in essential knowledge and experience concerning the practical problems of the management and development of fisheries of diverse types and of such a highly complicated nature as those of Bengal. Fortunately for me, owing to the emergency conditions then prevailing, a considerable part of Bengal rich in fishery resources (riverine, estuarine and foreshore fisheries) had been declared as a Denial Area and the following functions were assigned to the newly created Department of Fisheries:—

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[1] Hora, S. L.—*Rec. Ind. Mus.*, XXII, pp. 165–214, pls. IX–XII (1921).
[2] Hora, S. L.—*Journ. As. Soc. Bengal* (N.S.) XXVIII, pp. 197–205, pls. (1932).
[3] Hora, S. L.—*Journ. As. Soc. Bengal* (N.S.), XXX, pp. 1–15, pls. (1934).
[4] Hora, S. L.—*Curr. Science*, III, pp. 543–546 (1935).
[5] Hora, S. L.—*Journ. Bom. Nat. Hist. Soc.*, XXXVII, pp. 640–654 (1934).
[6] Hora, S. L.—*Journ. Roy. As. Soc. Bengal, Science*, VI, pp. 93–112 (1941).
[7] Jenkins, J. T.—*Curr. Science*, VII, pp. 43–44 (1938).
[8] Jenkins, J. T.—*Curr. Science*, VI, pp. 373–375 (1938).
[9] Herre, A. W.—*Curr. Science*, VI, pp. 263–266, (1938).
[10] Herre, A. W.—*Sci. and Culture*, VI, pp. 629–634 (1941).

(1) To re-organize the catching and distribution of fish under emergency conditions.
(2) To conserve the present supplies, with particular reference to the fisheries of immature fish.
(3) To conduct investigations into tank fisheries with a view to increase the food supply in the province, thereby aiding the 'Grow More Food' campaign.

Starting from scratch and finding to my great regret that all earlier records of the defunct Department of Fisheries were unobtainable, I determined to educate myself in the problems of Bengal fisheries. Three courses were adopted to achieve this objective, namely, (i) personal inspection of fisheries and contacts with fishermen and fish merchants by undertaking extensive tours all over Bengal, particularly to the areas which form sources of fish supply to Calcutta; the fisheries of some other provinces were also visited; (ii) extensive study of literature and codification of the material dealing with pond fisheries, and (iii) establishing contacts with specialists in the U. K. and the U. S. A. with knowledge of Indian or tropical fishery conditions and inviting their comments and suggestions on general or specific problems.

From 26th May, 1942, to 31st March, 1943, I spent 110 days on tour; in the following year ending 31st March, 1944, 107 days were spent on tour and in the third year 104 days. With the enormous expansion of the Department in 1945, more and more time had to be spent at headquarters, but I wish to emphasize that it would have been impossible for me to appreciate Bengal's fishery problems without these tours, for 'fisheries' is a field science and not a problem for discussion in office files. As a result of these tours and enquiries a note on the 'Sources of Fish Supply to Calcutta Markets' [1] and another on 'Suggestions for the development of Salt-water Bheris or Bhasa-badha fisheries in the Sundarbans' [2] were published. The effect of the effluent from the Quinine Factory at Mungpoo, District Darjeeling, was also thoroughly investigated and suggestions made for the improvement of fisheries of the Rungbee, Riyang and Teesta rivers.[3] Much other valuable information is now available in official papers for those who may wish to make use of it.

From the study of literature on tank cultural practices in India and abroad, it seemed necessary to publish a series of short articles in *Indian Farming* [4] so as to invite suggestions and criticism from practical fish farmers. For the Imperial Council of Agricultural Research a small pamphlet entitled 'Hints on the development of natural freshwater fisheries and fish farming' was prepared. In the article on 'Fish Farms: Objectives and Requirements' [5], the methods of developing tank fisheries are elucidated. In preparing this note, I received suggestions from a large number of specialists but all this labour was undertaken in the interest of self education. Lastly, a pamphlet on the 'Culture of Katli, *Barbus* (*Lissochilus*) *hexagonolepis* McClelland, in the Darjeeling Himalayas' [6] was prepared and the need for augmenting fish supply in the hills was indicated.

[1] Hora, S. L.—*Journ. Bombay Nat. Hist. Soc.*, XLIII, pp. 665–670 (1943).
[2] The first article of the series appeared in the issue of April 1943 and since then 15 articles have already been published.
[3] Hora, S. L. and Nair, K. K.—Fishery Development Pamphlet No. 1, Government of Bengal (1944).
[4] Hora, S. L. and Nair, K. K.—*Proc. Nat. Inst. Sci. India*, X, pp. 147–166 (1944).
[5] Hora, S. L.—*Journ. Roy. As. Soc. Bengal. Science*, XI, pp. 99–117 (1946).
[6] Hora, S. L. and Ahmad, Nazir.—*Govt. of Bengal, Fishery Development Pamphlet*, No. 2, pp. 1–8 (Alipore: 1946).

Under the auspices of the National Institute of Sciences of India, symposia were organized on the 'Factors Influencing the Spawning of Indian Carps' [1], on the 'Utilisation of Sewage for Fish Culture' [2] and on the 'Development of Indian Fisheries: Objectives and Requirements'.[3] The holding of these symposia enabled fishery officers from different parts of the country to meet and exchange views on diverse subjects of mutual interest. Much valuable information was thus collected in these meetings.

Further periodic meetings of Fishery Officers of Bengal were held to which representatives of other provinces were invited for holding discussions on specific problems of mutual interest. Minutes of such meetings were published by the Directorate of Fisheries, Bengal.

In making contacts with foreign specialists, I usually sent out a note and invited suggestions and criticism. Thus on the 10th June, 1943, copies of Dr. M. R. Naidu's 'Report on a Survey of the Fisheries of Bengal' (Bengal Government Press: 1939), on the 27th October, 1944, copies of a Syllabus for a course of training in Inland Fisheries, on the 18th December, 1945, copies of a programme of work for the Inland Fisheries Research Institute and on the 22nd March, 1946, copies of a note on 'Fish Farms: Objectives and Requirements' were sent out and valuable suggestions collected. Besides several subjects were discussed at length in correspondence.

My object in writing 'Development of Fisheries in India—Views of Specialists' is to provide for others the information I so sorely needed and to obtain which so much valuable time was spent not only by myself but by those experts who so ungrudgingly gave me the benefit of their experience and knowledge.

I hope, therefore, that this Bulletin will prove of real value to all those concerned with the improvement and development of fisheries of this great country, whose fishery potentialities are enormous.

ACKNOWLEDGMENTS.

My thanks are due to a large number of fishery scientists in India and abroad, too numerous to be mentioned by names in this place, for their manifold kindnesses and courtesies, but particular mention must be made of the undermentioned whose views have provided the material for the present publication. All fishery students will join with me in mourning the great loss which our science has sustained by the premature death of Dr. Stanley W. Kemp whose foresight, great knowledge, earnestness and industry would have been of inestimable value in developing the fisheries of all parts of the British Commonwealth.

Professor L. F. de Beaufort, Director of the Zoological Museum, Amsterdam, Holland.

Captain W. R. Burgess, Late Assistant Director of Fisheries, Bengal (Marine and Estuarine), Australia.

Col. W. R. Burton, Keen Angler and Sportsman, Bangalore, India.

Mr. L. K. Elmhirst, Late Agricultural Adviser to the Government of Bengal, United Kingdom.

Dr. J. D. F. Hardenberg, Laboratorium voor het Onderzock der Zee, Batavia.

[1] *Proc. Nat. Inst. Sci. India*, XI, pp. 303–330 (1945).
[2] *Proc. Nat. Inst. Sci. India*, X, pp. 441–443 (1944).
[3] *Proc. Nat. Inst. Sci. India*, XII, pp. 288–290 (1946).

Dr. Albert W. Herre, Formerly Chief, Division of Fisheries, Manila, Philippine Islands. Curator of Fishes, Zoological Museum, Stanford University, California, U.S.A.
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Major A. St. J. Macdonald, Keen Angler and Sportsman, India.
Dr. George S. Myers, Professor of Biology and Curator Zoological Collections, Stanford University, California, U.S.A.
Dr. H. Thompson, Controller of Fisheries, Australia.

VIEWS OF SPECIALISTS.

FISHERIES ADMINISTRATION.

Stanley W. Kemp: Need for an All-India Co-ordinated Effort; Improvement of supplies through Administrative Measures; Need for an Administrative Section; Fishery Statistics; Liaison between Administrative and Research Personnel; Technological work. *R. W. Burton*: Need for propaganda. *James Hornell*: Socio-economic work; Marketing of Fish; Legislation regarding exploitation of Hilsa fisheries. *L. K. Elmhirst*: Socio-economic work. *St. A. Macdonald*: Need for Judicious exploitation of fisheries. *Albert W. Herre*: Time-scale Planning.

Stanley W. Kemp.

Need for an All-India Co-ordinated Effort.—The problems of adjacent provinces, sometimes of all India, are the same or similar, and it will often happen that two or more provinces are concerned in a particular piece of work, for fish have no respect for provincial boundaries. Thus Dr. Travis Jenkins, many years ago, tracked the spawning Hilsa up the rivers to the confine of Bengal; he telegraphed for permission to proceed into the U.P., but was refused and was thus unable to discover the location of the spawning grounds. Migratory marine fish will also present similar difficulties. The recent action of the Government of India in appointing a Fisheries Development Adviser is thus a step, though only a small one, in the right direction—one hopes it may be followed by the initiation of an all-India Fisheries Service.

Improvement of Supplies through Administrative Measures.—There is, however, one aspect which I want to stress, as giving in my opinion the best chance of an early improvement in fish supplies in Bengal, and that is the urgent need for proper administrative measures. At present the fisheries of the Province, especially of the extensive estuarine tracts of the Sunderbans, are exceedingly badly organized. There is no proper transport from the fishing centres to road or rail head, no sufficiently good arrangements for refrigeration, and in all the main towns there are rings in the fish-markets, which maintain extortionate prices while keeping the fihermen themselves at the barest level of subsistence. I believe that, in brief, to be a true picture, and that if these and similar difficulties could be overcome the amount of fish in the towns could be enormously increased.

On every hand the utmost opposition from vested interests is to be expected and a man with immense drive and armed with almost autocratic powers will be needed. A superman is required if the market rings are to be broken, and the fisherman assured a reasonable return for his labours.

Transport is perhaps a more manageable problem, for it should be possible to organize fleets of motor-boats as fish carriers on suitable routes connecting with lorry or rail transport using refrigerated containers; and though subsidies would probably be needed at first in due course transport should be able to pay its way. But in all these matters, and in arranging advances to ignorant fishermen for purchase of boats and gear, one shudders to think of the infinite possibilities for graft which are opened up.

The first point that strikes me is that immense advances in the development of the fisheries can be achieved by suitable administrative measures: piers, jetties and other facilities for landing the fish are badly needed, greatly improved arrangements are wanted for rapid despatch from the fishing grounds to centres where rail or lorry transport is available, refrigerating vans and ice supplies call for consideration and new systems of marketing must be introduced which will suppress the rings formed to keep up prices and (perhaps through the organization of co-operative societies) will ensure a reasonable profit to the actual fishermen.

Need for an Administrative Section.—All this, in my view, is purely administrative work with which you should not be expected to concern yourself very closely. Your help, as a consultant, will no doubt be continually needed, but you will have more than enough to do on the scientific side. A separate administrative section is thus clearly necessary, and I myself think that the chief of this section should have the same salary and status as yourself. You should be consulted in his selection, and it is obvious that you will need to work together very harmoniously. It is evident to me that with the enormous potential richness of the Bengal fisheries a large increase in the fish supplies to the towns could rapidly be brought about by administrative measures, provided only that the officers concerned show energy and determination in the difficult practical and social problems they may have to face.

During the past year or so I have been a member of the Colonial Fisheries Advisory Committee, and in considering the development of Colonial fisheries we have recommended (and the Secretary of State has approved) the formation of two services; a Colonial Fisheries Service, which will undertake the administrative work (collection of dues, enforcement of regulations; loans to fishermen for nets and gear, compilation of statistics and so forth) and will be responsible to the local Government, and, secondly, the Colonial Fisheries Research Service with suitable research stations responsible directly to the Secretary of State for the Colonies. In India also the same plan should be followed—an all-India Fisheries Research Service and provincial administrative departments. The administrative officers need not be trained scientifically, but they must of course work in very close touch with the research staff.

Fishery Statistics.—I would, however, add this—that it is of fundamental importance, not only for commercial purposes, but for the study of the effect of fishing operations on the stocks of fish (with a close eye on the dangers of overfishing) that quite elaborate fishery statistics should be kept, and closely studied.

It will no doubt be difficult to organize an efficient system of collection, and this will be primarily the business of the administrative staff, but it will be worth while expending a lot of energy and money on this, for adequate fishery statistics are an essential basis for fishery research work.

The primary data required for each important species are quantities caught and amount of fishing power expended—*e.g.* number and size of boats employed, number of nets, and if possible amount of time spent fishing. Information as to size-distribution of catch is also of great value;

if the fish are sorted into size-categories on the market, the quantities of each category should be recorded separately. Periodic measurements of random samples of the catches or landings are very desirable.

Liaison between Administration and Research Personnel.—When the time has come that schemes should be carried forward by the administrative officers with only occasional scientific supervision, it is the former who will undertake the necessary propaganda, the development of particular sites and the arrangements of such subsidies as may be needed. This will not mean that scientific work in connection with these projects is ended. Far from it. For it is apparent that the methods suitable in Bengal will very likely not suit other provinces. It is probable that other species will prove to be the best and it is by no means unlikely that variations in the technique will be required. Therefore, if my advice is taken on the inclusive character of the all-India research service, the Bengal fresh-water staff, with all the practical experience they have already gained, should proceed to suitable areas in other provinces and set to work to find out what modifications of technique are appropriate in the new locality. Whatever you may think of these suggestions you must admit that this is the way to utilize scientific staff, which (so far as really good men are concerned) will undoubtedly be in short supply for many years, to the best possible advantage.

Technological work.—But in one line of work administrative and scientific staffs might perhaps combine: this is in fish drying and fish preservation. This is obviously an important subject: if dried fish, prepared near the fishing grounds, can be produced in an acceptable quality some at least of the difficulties of refrigeration and transport can be overcome. Existing methods, using the sun for drying, are not well suited to the damp climate of Bengal and in this country where the subject has been closely studied (at the Torry Research Laboratory, Aberdeen) considerable progress has been made with artificial driers. An initial point to be considered is the kind of product which would be regarded as palatable in Bengal. In W. Africa experimental fishmeal plants are to be tried and it appears that a crude fish meal, made from whole fish and of strong flavour, is more acceptable to the African than a more refined product. It may be that fish-meal would not be favoured in Bengal; if so it will be unfortunate since it can be produced very cheaply. But however this may be, it is evident that experiments should be begun at once with suitable type of artificial driers for both fish and prawns, and at the same time salting and other preservation processes should be examined with a view to their improvement or extension. A start could probably be made by consulting Dr. Reay at Torry and the methods, perhaps not very up-to-date, which are followed in the Madras Presidency, should be looked into. But at the first possible moment two of your staff, preferably chemists or with good chemical knowledge, should come to Aberdeen to make a thorough study of the technique of fish processing.

Need for propaganda.—Just as the treatment of Malaria has been brought to the notice of the people by means of broadcasts and propaganda

R. W. Burton.

vans, so should the necessity of conservation of fish supplies of the country be brought to the notice of the people in even the remotest hamlets; and especially will it have to be impressed on the people that it is in their own vital interests to assist in putting a stop to practices fatal to their own food supply.

Without the willing, and eager, and interested, co-operation of the people, and of all those who have control over fishing waters (contractors and others), the energies of the Institute of Fisheries will be largely abortive.

Research—Propaganda—Organization, and more propaganda for until there is willing and intelligent co-operation on part of the millions of the rural areas progress will be slow, and there will be many disappointments.

Socio-economic work.—Technical instruction, co-operative societies and savings banks should be primary objects in any Fisheries scheme of development; the same applies to the opening of new markets in large centres of population in order that the middleman may be as far as possible eliminated.

James Hornell.

Marketing of fish.—I attach the greatest possible importance to all efforts to improve the condition in which fish arrive at the market centres. Especially do the men need to be taught how beneficial scrupulous cleanliness is to the keeping quality of fish in transit; also the preservative value of salt properly applied, protection from the sun and more than anything else, the great value of gutting and bleeding. Careful handling of the catch to avoid bruising the soft flesh should be emphasized.

Legislation regarding exploitation of Hilsa fisheries.—Many essential facts are still lacking in the knowledge of the life-history of the Hilsa; these *must* be ascertained before any legislative enactments be proposed.

Socio-economic Work.—For how many hundreds of thousands of Bengalis is fishing a means of livelihood and a way of life, and art and a craft? How often is it little more than a crude and hungry existence, an intolerable burden of oppression or a worn out tradition? Without the help of science, of research, or education, of plan, and without a sense of social purpose and responsibility, has the life of the fisherman, his wife or child any basis of assurance, any clarity of meaning or any conviction of reality? How profound is his pessimism! How depressed is his outlook! Today is there any reason why, with the help of science, business organization, intelligent self-help, and public support, he should not be proud, self-confident and an all-round intelligent citizen? None!

L. K. Elmhirst.

But to help him, must we not respect his art and his age-long tradition, his sterling qualities of courage and character. Only thus shall we win his respect and confidence. Only then will he feel that we come to him to help him increase his self-respect and not to undermine it. Only then shall we be able to equip him with keener tools with which to carry on his trade, and with a social structure and a business organization that will guarantee him not only a sure living but a rich life and a creative leisure.

Need for judicious exploitation of Fisheries.—Surely the most important factor is to make the farmer Fish Culture minded?

It is a huge question; especially in the thickly populated parts of Bengal and Bihar, where fish diet makes up such a large portion of their food, and where most of the tanks are privately owned and a source of revenue to the Zemindar.

St. A. Macdonald.

Fishing rights are sold by auction to the highest bidder, who proceeds to denude the tank of every living thing! This takes place yearly and gives little chance of recovery to the natural stocking that takes place each Monsoon.

In large tanks and lakes, they cannot completely exhaust the stocks, as is the case in the small shallow ones.

The Monsoon streams that are a means of yearly stocking of fish, fare no less favourable, as 'Baris' or Bamboo wiers are put across at intervals throughout its length, and everything an inch or more is trapped in closely meshed cage baskets. These are erected both when the fish are running up into Jheels, lakes, etc., and again when the breeding urge takes and the

fish try and move down into the larger rivers. These migrations are called in Bihar and the Eastern U.P. 'Biswar' and 'Ahwar'.

To try and convince people hard put for food, to return all small fish, would be a huge task, and nothing short of Government legislation would meet the case. The above note refers to naturally fed tanks which get their water supply from floods during the Monsoons.

Albert W. Herre.

Time-scale Planning.—A ten year plan for the development of Bengal fisheries be drawn up at once, if it has not already been done. Supplementing this, a twenty-five year plan should be outlined; this had best be divided into five year sections. Such a plan will give definite objectives, and will likewise serve to show the quality and number of scientific men, technical assistants, departmental heads and other staff members needed.

TRAINING OF PERSONNEL FOR FISHERIES SERVICE.

Stanley W. Kemp: Paucity of men and ineffectiveness of isolated efforts; Advanced Training in Fisheries; Foreign Training in the U.K. *George S. Myers*: Lesson from Brazil; Limitations of Foreign Experts; Foreign Training.

Stanley W. Kemp.

Paucity of men and ineffectiveness of isolated efforts.—A major obstacle has always been that fisheries is a transferred subject. Some provinces have from time to time had one man on fisheries work, most have had none; Madras always the most progressive since the days of J. Hornell, has two or three. In these conditions satisfactory work seems to me to be largely impossible. Nothing much can be expected from a single man isolated in a particular province.

Advanced Training in Fisheries.—The real difficulty is in finding competent people for the scientific staff and administrators who are capable of carrying out the sweeping reforms that are wanted. Some help in training scientific staff could be given in this country (U.K.). The Colonial Office will be awarding post-graduate studentships for those selected for the Colonial Fisheries Service and a special course of fishery instruction covering all branches of the subject and lasting probably for one year, is now being arranged. It will no doubt be possible for Indian fishery students to join these classes.

Foreign Training in the U.K.—My plan would be to put as many good graduates as possible through your freshwater course, set them to work in Bengal or elsewhere and, in a year or so, select the brightest of them to come to this country for our fisheries course. There is, to take only one side of the work, a lot to be learnt on how the job of obtaining the essential biological knowledge of an important fish should be tackled. Unless done in the right way a great deal of time will certainly be wasted. And even when all the basic information is at hand the methods of applying the knowledge so that the condition of the stock is fully apprehended (knowledge to be used in increasing or decreasing the rate of fishing, mesh of nets and so forth) must also be learnt. No one in India has had personal experience of these matters and if this very important work is to make progress it seems to me quite essential that your people should come over here and learn it from those who have gone through the mill and have done these things themselves. Once the methods have been assimilated and applied to some species of Indian fishes it should be possible to give instruction in India. This is only one branch of the work—there are a number of others which it would at present be very difficult to teach in India.

As soon as it is possible you should send at least one of your staff, preferably two, both of whom should have graduated in chemistry, for special training in technological methods at Aberdeen.

Lesson from Brazil.—All through the later part of my thinking, I was struck with the resemblance of Brazilian problems to those of India, and one of my chief fears has been that you might, through misunderstanding of conditions here (U.S.A.), fall into the same state of admiration of our fisheries 'progress' that others have, and believe that men connected with agencies so successful as some of ours must perforce be those on whose work to pattern your own.

George S. Myers.

Limitations of Foreign Experts.—My strong advice is this: If you ever should wish any fishery experts from outside India to come as advisers, pick with extreme care, and with the provision that the man or men spend not less than one year in India, or preferably, two. Accept as final none of an adviser's recommendations until he has been there at least six or eight months, for in a shorter period he will not have sufficient experience with conditions in India for his advice to be of the best. This is especially true of Americans, who, I regret to say, are often extremely provincial people with not much desire to look deeply into the civilizations or problems of other peoples.

Foreign Training.—What I do wish is that you could convince the Indian Government of the usefulness of sending a few of your men out of India, as fishery students, for periods of not less than two years. Less than two years is not enough, as both Dr. Walford and I have discovered in the case of students from Central and South America. And I would hope that at least the first part of their sojourn, or better, all of it, could be spent at Stanford by the few who might come to America. I do not say that we are the only persons who are good fishery biologists. That would be absurd. But only about four universities in the States (and perhaps now in the world) specialize in fishery training, and of these Stanford is the only one where there are men (Dr. Herre and myself) with long first-hand experience in tropical and Asiatic fishery problems. Besides, our Professor Rich is the world's chief investigator of the Pacific salmon, an excellent limnologist, and one of the foremost general fishery biologists in the country, while Prof. Bolin is a good oceanographer and a specialist in fish and other marine ecology. Professor Weymouth, of our Physiology Department, is a leading exponent of mathematical methods and our chief authority on the shrimp and other crustacean fisheries.

Various Types of Fisheries.

Stanley W. Kemp: Importance of fresh-water and estuarine fisheries; Inshore Fisheries; Sea Fisheries. *James Hornell*: Sea Fisheries. *H. Thompson*: Sundarbans Fisheries.

Importance of Fresh-water and Estuarine Fisheries.—Freshwater and estuarine fishes afford much the best prospects of the considerable and immediate increase in fish supplies which India so badly needs.

Stanley W. Kemp.

Inshore Fisheries.—Of the inshore marine fisheries at Cox's Bazar and elsewhere, more knowledge must be acquired before much can be done. A proper survey of these fisheries and the fishes on which they are based is the first step. It would appear that power-driven boats would be a very great advantage if there are people capable of maintaining them and it may well be that considerable improvements in nets and gear could be introduced.

Sea Fisheries.—In the sea-fisheries there is undoubtedly a very large potential supply. In the year 1908 or earlier the Government of Bengal brought over a steam-trawler, the 'Golden Crown', complete with crew. They trawled assiduously off the mouth of the Hooghli and brought in very large quantities of fish, including huge saw-fish and skates 8′ or more across. Good food, all of it, but the market ring in Calcutta asserted itself, strange fish were not looked on with favour, and no sale could be found for the bulk of the catch. It is I believe a fact that the Bengali much prefers carp and other fish which to us are disagreeably muddy in flavour.

This experiment could be tried again and if proper arrangements were made beforehand for the disposal of the catch, I see no reason why it would not be successful, and an Indian trawling industry might be started. The 'Golden Crown' files, if still available, should provide a wealth of information. But it will be difficult to get trawlers at the present time and it will of course be essential to bring them out with skipper, crew and all gear.

James Hornell.

Regarding marine fisheries, there are many more ways of effecting improvements than in the case of inland fisheries, where fish breeding as well as fish catching has to be attended to.

At sea, new methods and new types of fishing boats are urgently needed. This work can be done only if efficient teachers, professional fishermen skilled in their respective methods, be employed to introduce the new devices and teach the proper way to work them in order to obtain satisfactory results. Among these new methods I strongly advocate:—

(*a*) The introduction of the *Prawn-trawl* (either the beam or the otter type) on smooth ground where prawns abound—the species of *Penaeus* in particular; and

(*b*) The utilization of the Danish Seine in localities where fishes of demersal habit abound, *i.e.* those living on or near the bottom. This method cannot be learned from books or verbal instruction; it must be taught practically by a skilled fisherman who must be chosen most carefully.

Excellent shore seines are already in use on parts of the Indian coastline and need little improvement except that the very large ones would be greatly improved if mechanical power were introduced for the heavy work of hauling in; a handwinch would be immensely labour-saving and, when the net is of exceptional length, a motor boat should be used to shoot the net.

H. Thompson.

Sundarbans Fisheries.—The proposals put forward for exploiting the fisheries of the Sundarbans appear to me quite sound, and cover broad requirements, e.g. trial and methods of fishing, obtaining biological knowledge for conservation policy, and social measures required to ameliorate the lot of fishermen.

Mr. Rochford, our hydrologist here, has found that the river mud has a property of absorbing phosphate, thus making it available to estuarine fauna. Quite possibly the same thing happens in the Sundarbans.

Fish Culture.

General Observations, with particular reference to Carp Culture.

Stanley W. Kemp: Importance of Carp Culture to Bengal; Fry Trade Development. *A. W. Herre*: Problems of Pond Culture; Experimental Fish Farm; Construction of Fish Ponds; Fertilizing of Fish Ponds; Fish Cultural Practices in China. *James Hornell*: Experimental Culture Ponds.

Importance of Carp Culture to Bengal.—Carp Culture probably affords the best opportunities for a rapid increase in fish supplies, and it is a line of work on which Bengal should concentrate much of its attention. Very remarkable results have been obtained in recent years by the Jews in Palestine and there seems no reason why the same or similar methods should not be employed in Bengal. Something in this way is already done, but existing methods are very defective and could be vastly improved. I feel sure fish farming has a great future and that, if you can get really good energetic people to assist you, you are bound to be successful.

Fry Trade Development.—The demand for fry, large at present, may be expected to increase greatly; the fishery department itself will be unable to fill it and you will have to encourage firms or private individuals: the best arrangement would be to have a list of people whose fish-farms or fry collecting arrangements were under your constant supervision, and these would be authorized to sell fry under certificate from your department.

Albert W. Herre.

Problems of Pond Culture.—Real carp cultivation scarcely exists in India. The collecting of specific fry of rapidly growing vegetarian or molluscan-feeding species, the fertilization of the water, and the elimination of undesirable or highly voracious and carnivorous kinds, are lines which should be intensively pursued, so as to place the industry upon a firm basis. This is a field of great promise. It will be necessary to eliminate all murrel, cat-fishes, eels, and other carnivorous fishes from every carp pond. A more difficult task will be to keep them out.

The rate of growth of fresh-water fishes, and the size at which sexual maturity is reached, are both very important topics, and must be carefully investigated. Closely related species are known to differ widely in these respects in some cases, so that one may be highly profitable when cultured in ponds, the other of little worth. No doubt there is still much to be learned about many of the Indian carps in respect to their suitability for pond culture.

I found in the Philippines that it was difficult to train pond owners not to overstock their waters. Far too many fry were put in the ponds.

Chinese experience says to remove the bottom sediment annually, or at most biennially. Ponds become too foul when left uncleaned for five or ten years.

Experimental Fish Farm.—There should be an experimental farm to determine what species of Indian carps are best suited to pond culture. Closely related species may vary widely in rapidity of growth, maximum size, etc. Where these matters are not clearly and positively known, much time, effort, and pond space are wasted.

The same farm should also determine the optimum number of fish to be reared in a pond. It is not enough to rear one species in a pond. Several species may be grown in a pond without detriment, provided each kind has its own physiological niche. A vegetable feeder, a plankton feeder, one eating crustacea and worms, and a molluscan feeder, can live in the same pond. Five or six kinds of carp may live together where each has its own food supply. A good deal of experimental work has been done along these lines in China. I believe there is need for similar work in India.

Construction of Fish Ponds.—It might be well to emphasize that much soil is unsuited for pond culture—salinity, alkalinity, porosity, etc., must be considered and before starting to develop a fish pond, a technical officer should always be consulted.

Where there are several tanks in a farm, they should be contiguous so that water and fish can be run from one to another, except that there can be no reversal after reaching the lowest. The tanks of a fish farm are best handled when they are really but subdivisions of a single large tank, separated from each other by dikes.

Fertilizing of Fish Ponds.—Because of the status of cattle in India, and the use of cow dung as fuel, the fertilization of fish ponds may present some difficulties if there is a considerable increase in their acreage. At the same time, I remember the 'soupy' condition of the water of the little ponds about Palta (village ponds not the waterworks ponds) and of ponds I saw in Central Province around Bisrampur. There the water was as full of organic matter as a Chinese pond with privies along its margin.

Fish Cultural Practices in China.—Fish culture in Bengal is the most promising field for investigation. Though the pond culture of carps is more than 2,000 years old in China, it has received a fresh impetus in recent years and a great deal of experimental work was being carried on when the Japanese stopped it by war. I assume you have the reports by Mr. Lin and other Chinese investigators. I visited the ponds near Hong Kong on my last trip, and studied briefly their methods. A hint of them is given in the Journal of the Hong Kong Fisheries Research Station for September, 1940.

Chinese fish farmers have worked out, by rule of thumb, ways of keeping several kinds of carps in ponds simultaneously. By utilizing kinds whose habits do not interfere seriously, they are able to keep from 3 to 5 species together. While the ration is not adjusted with scientific accuracy, it is good enough to get remunerative practical results. Much more experimental work is needed to get the ratios more perfectly adjusted. I do not think you have any large Indian carps corresponding to the Chinese sub-family Hypophthalminae. Out of the vast number of Indian carps you will certainly be able to make a wise selection. I spent nearly two weeks at the Tapah Fisheries Station, 7½ miles from the railroad station of Tapah Road, Perak, where a young Tamil, Tagiaradjan, was raising carps and other fishes in order to determine what could be used for pond culture in augmenting the native food supply.

Experimental Culture Ponds.—I consider that the first matter requiring attention is the provision of a series of fresh-water culture ponds wherein experiments may be carried out to ascertain what species of fresh-water and estuarine fishes give the best results as regards tolerance of variations in the salinity of the water, rapidity of growth, foods most useful in promoting rapid growth and suitable as regards cost, the best ways of manuring them, and the most satisfactory method of transporting fish to market both in the living and dead condition. Various other related problems will occur to the superior officers in charge.

James Hornell.

Culture of Mullets, Betki and Cat-fishes.

James Hornell: Need for Mullet Culture; Hints on Mullet Culture. *Albert W. Herre*: Possibilities of Mullet Culture; Pond Culture of Betki; Cat-fish Culture.

Need for Mullet Culture.—Mullet culture, such as is practised at Comacchio in Italy, is most important and a very profitable branch of work, as mulletries are already in existence and only require to be improved along well-recognized lines, with means arranged for the regular supply of adequate quantities of fry

James Hornell.

of those species known to be tolerant of lowered salinity and of quick growth. Whether it is economical to add artificially prepared food to their dietary is a matter for enquiry and will depend upon what seeds and grains are locally available at a cost which will prove remunerative.

Hints on Mullet Culture.—Certain species of mullet can be acclimatized to live in fresh-water. These are the ones to select for rearing in culture ponds made by sluice-bunding some of the smaller blind khals; *bekti* should also be tried—they would probably live amicably together. As for stocking with mullet it will probably not be necessary to do anything more than open *part* of the sluice (say a door) when floods are on, provided that it be found that the mullet fry are trying to go up against the current at this time; this is their habit in other localities, e.g. Italy, where mullet farming is extensively carried on.

Possibilities of Mullet Culture.—Several mullets might be suitable for pond culture in India in brackish or fresh water, as well as salt water.

Albert W. Herre.

In the Philippines certain kinds of mullet enter rivers and lakes, where they remain until they are nearly ready to spawn, when they return to the sea. Some attain a large size in fresh water, as long as one's arm, and are delicious eating, much finer than those living in the sea. Of course, some kinds, as *M. dussumeri*, never get large, but are often very abundant in bangos (*Chanos chanos*) ponds, and make a good growth. Your invaluable Pulta experience should give you a good idea about the kinds of mullet most suitable for pond culture in Bengal. The mullet cultivated in the New Territory, Hong Kong, is *Mugil cephalus*, one of the most valuable kinds and occurring in India. It is the *Mugil oeur* of Day. In the Bangos ponds around Manila Bay several kinds of mullet occur, often in abundance, and are marketed extensively. The commonest is *Mugil dussemieri*, also an Indian species. *Mugil corsula* is very common in the Ganges delta, and its growth in the settling ponds at Pulta would indicate its desirability in either fresh or brackish water pond culture. Most kinds of mullet thrive in either fresh or salt water. All the larger kinds of mullet in Indian waters should be used in experimental studies of pond culture.

Pond Culture of Betki.—The pond culture of betki is not feasible. It is a highly carnivorous fish, and our experience with bangos (*Chanos chanos*) in ponds around Manila Bay shows that betki is destructive to all other fishes in ponds. The number of betki it is possible to grow in a pond is too limited to be commercially profitable. Only vegetarian fishes are likely to be profitable in pond culture, especially true in India where there are no large amounts of waste animal protein.

Cat-fish Culture.—Certain species of Cat-fishes are valued as food by the common people, and also breed freely in ponds. There is need for more knowledge concerning them, and also for clarification of what is already known about them.

Culture of Exotic Fishes.

***James Hornell*: Culture of Mirror Carp, etc.; *Albert W. Herre*: Gurami Culture; Culture of *Chanos*.**

Culture of Mirror Carp, etc.—I would go further afield and introduce some of the varieties of large carp reared so extensively in Central Europe

James Hornell.

(Mirror Carp, etc.). These are very easily cultured in ponds and fetch a good price wherever there are people, who, like the Jews, like to have the killing of their animals done

after a particular ritual. They are easily transported alive and may be kept alive in a market in a tub of water, for several hours, or longer if the water be changed at intervals.

Gurami Culture.—Bengal is probably too far north for gurami culture, and other species of the Anabantidae. Gurami are especially valuable for fresh-water pond cultivation, and the development of gurami fish farms should be vigorously supported wherever the climate allows this savory fish to be grown successfully.

Albert W. Herre.

Culture of Chanos.—My own paper on *Chanos chanos*, 'Bangos Culture in the Philippines' you have, no doubt, as I sent it to you when it appeared. This paper was amplified later on by two members of my staff, Montalban and Martin, and published under the following title:—

Cultivation of Bangos in the Philippines.—It is in the *Phil. Journal of Science*, as my own paper was in Vol. 47, No. 1, January, 1932. Authors Wallace Adams, H. R. Montalban, and Claro Martin.

FISH TECHNOLOGY.

Stanley W. Kemp: Scope and Problems of Fish Technology. *P. M. Kharegat*: Need for Organized Production for Large-scale Technological Operations. *James Hornell*: Freezing; Dried Fish; Kippered Hilsa; Canning; Fish Meal, Fertilizer and Oil. *Albert W. Herre*: Need for an Experimental Fish Curing Yard; Fish Meal.

Scope and Problems of Fish Technology.—In a humid country like Bengal it must always be difficult to sun-dry fish and prawns properly and there appears to me to be no doubt that experimental work with artificial driers is called for. Canning is another process that needs consideration but as I understand that canned fish is not much appreciated in Bengal, drying will be the first thing to tackle. I see from the report that artificial driers are in use in S. India and that printed particulars of these plants are available. If I were starting on this kind of work my first step would be to obtain the pamphlets and send them to Dr. G. A. Reay, Torry Research Station, Aberdeen, for criticism of the methods employed. Dr. Reay is our leading expert on these matters and I am sure you will find him very helpful; methods are continually being improved and it may be that those now used in South India are no longer the best available.

Stanley W. Kemp.

As a beginning I imagine you will want at least two experimental driers for fish, two for prawns and one for preparing fish meal, all situated at centres where ample supplies are available. A small charge for drying should ultimately cover the costs of the work.

Need for Organized Production for Large-scale Technological Operations.—It is all very well to talk about fish preservation, but why do not these technicians induce private firms to take up this work. The answer is that it does not pay as a commercial proposition. You cannot run a factory if you have an excess for 3 or 4 days and nothing for the next week. Unless production is organized to secure regular supplies in adequate quantities, factories cannot function. The first step is and must continue to be organized production, followed by refrigeration to prevent spoilage, it is only after these have been attended to that there will be any scope for canning, dehydration, etc.

P. M. Kharegat.

Freezing.—For the richer classes who can afford to pay high prices, brine freezing of the best qualities (*betki*, the Indian salmon, etc.) by a well-capitalized Freezing Company with their own retail shops in Calcutta and other populous centres, would probably find this industry profitable, provided the factory could be located

James Hornell.

at a fishing centre where large supplies of fish could be obtained direct from the nets.

Dried Fish.—Oily fish should not be sun-dried; only 'white' fish and small fish cure well in the sun. Sanitary rules should be made and enforced to ensure hygienic methods and adequate inspection arranged; punishment for infringement is necessary. Salting in various ways requires experiment and whatever methods are found correct for specific species of fishes should then be brought to the notice of curers. In Bengal climatic conditions differ so greatly from those of Europe that the methods found correct in Europe may not accord with local Bengal conditions; the difference in regard to the species treated in the two areas further complicates the situation; practical experiments are absolutely essential.

Kippered Hilsa.—The *kippering* of Hilsa is a promising method of preparation and should be introduced as quickly as possible.

Canning.—One demonstration cannery should be built at as early a date as possible for herein lies great opportunities for expanding the consumption of fish by a method which will enable the fish treated to remain good for an indefinite period; it would also tend to create an export trade. Canning offers a great commercial opening to enterprising firms.

What I do hope to see before long is a *commercial* cannery in India producing canned fish products on a scale comparable to what the Americans do in regard to Salmon and 'Pilchards' and the Japanese did before the war in the canning of crab meat. Indian sardines are quite as good as the French product and immeasurably superior to what the Americans call 'Pilchards'. Indian prawns should be saleable much cheaper and quite equal to the American pack of prawns. Same with regard to fish oil, fish meal and fish fertilizer.

Fish meal, fertilizer and oil.—I cannot press too urgently the enormous field for development which exists in regard to these three items of work. All are of the utmost value to the community and there is a great future for them if adequate attention be devoted to their development. Small, inexpensive factories have been most successful in Madras *when sardines have been* abundant, but unfortunately this fishery is erratic and when a poor season recurs, the factories are not profitable. This seasonal disability does not exist in Bengal where there is fair regularity in the annual richness of the fisheries from which the necessary waste material is obtained. Of the three products, meal and fertilizer are the most important; oily fishes in Bengal are of less importance but this is not to say that a fish-oil industry is not to be considered seriously.

FISHING CRAFT AND GEAR.

S. W. Kemp: Introduction of new types of nets; Government Factory for manufacture of netting; Motor-boats or Outboard Motors for Fishing. *James Hornell*: Netting Machine; Steam Trawling; Local Methods. *Albert W. Herre*: Improvement of Craft and Gear. *R. W. Burton*: Preservation of nets and improvement of fishing boats. *L. F. de Beaufort, J. D. F. Hardenberg, Albert W. Herre*: European methods of fishing *versus* Japanese methods. *W. R. Burgess*: Improvement in Fishing Craft and Gear.

S. W. Kemp.

Introduction of new types of nets.—It is possible that the introduction of new types of net will sometimes prove effective, but for the present, and particularly with existing difficulties in importing gears, it appears to me best to leave the fishermen to their traditional methods. If marketing difficulties are overcome and the fishermen get a better price, supplies will increase automatically.

Government Factory for manufacture of netting.—It may well be necessary to establish a Government factory for the manufacture of netting.

Motor-boats or Outboard Motors for Fishing.—The introduction of motor-boats or outboard motors for fishing, would no doubt be an advantage but it appears to me that very great caution will be needed since most of the fishermen will have no knowledge of machinery and would not be able to look after the engine properly; but the experiment may be tried in a few places where a reliable man is available.

Netting Machine.—This should be operated by private enterprise, if possible; if no firm will take this up, then a demonstration machine might be necessary. But these machines require skilful operation and the one set up by the Madras Fisheries was never successfully used. This means that no suitable operator was on the staff. Either an Indian should receive training in England or an English workman should be engaged for a year to teach operations. It is because of this that I suggest private enterprise. Once started, the trade of machine netting should prove very remunerative.

James Hornell.

Steam Trawling.—I do not advocate steam-trawling yet awhile. There is much that can be done at once in other ways to improve fishing methods without risking such a fiasco as has invariably followed the premature attempts hitherto made by the Government of Bengal, Bombay, Madras, Ceylon and Burma; the time is not yet ripe and will not be until the Government has improved transport by rail by which refrigerated cars with satisfactory means for the keeping of fish in good condition from the port of arrival until they reach the consuming centre, will be available to the fish trade. Till the problem of fish distribution by rail and motor lorry be solved, it seems useless to catch fish by such wholesale and efficient methods as steam trawling and Danish seining on a really big scale.

Local Method.—I have found that in the majority of instances the methods of fishing evolved locally have good reason for their continued existence, based upon long standing experience and with intimate acquaintance with the habits of the particular kind of fish concerned, habits which may be unusual and different from what is usual in other localities—differences brought about by some local peculiarities of the environment. Hence I find the local methods always well worth studying; instead of suggesting a change over to a new method which may at first sight appear likely to be more effective. I would advise that a trial should first be made to find some *simple* way of making the local method more satisfactory in catching power.

Improvement of Craft and Gear.—It will be a very difficult matter to alter these native methods, but there can be no great improvement until power boats of some sort, and better styles of nets, are adopted. The Manila Bay fishermen fought the introduction of power boats, and clung tenaciously to their ancient style of fine meshed nets for many years. Finally power boats began to be accepted, and in recent years a motor-boat would tow a fleet of old style boats out to the fishing grounds, and bring them back when laden, thus enabling them to get their fish to market in far better condition than ever before. Along with the introduction of power boats must go eventually the more difficult task of bringing about the use of keel-built boats, with cargo space.

Albert W. Herre.

Preservation of nets and Improvement of fishing boats.—I would add introduction of better methods of preventing rot of nets and lines; and improvement of fishing boats on some parts of the Coast. For instance, the Ratnagiri Boats are much superior to the craft in use further south, so that the Ratnagiri fishermen

R. W. Burton.

can go further out to sea and bring in catches of fish unobtainable by the men with inferior boats and equipment.

European methods of fishing versus *Japanese methods.*—Do not try European methods. The experiments made with North Sea trawler in the Java Sea have not been successful. Since the Japanese started fishery in the Indo-Australian Archipelago about twenty years ago, the fish markets in Java were over-flooded with a quantity of species, which hitherto were never brought to market. Hence a study of the Japanese fishery methods ought to be made.

L. F. de Beaufort.

According to me trawl fisheries are not well possible in Indian waters, may be a very few small areas excepted. Research in the Laboratory for Investigation of the Sea at Batavia proved that the amount of living material in and on the sea bottom is only a small fraction of the amount of the same in the North Sea. As this living material can be assumed to be basis of food for the bottom fish one can safely conclude that the total amount of suitable trawl fish will be much less too than in the North Sea. Our statistical data are most probably partially or totally lost now, but the results of our research are given above. It is a great pity that it cannot be published in detail as we planned before the war.

J.D.F. Hardenberg.

In spite of all efforts, the only real advances made in fisheries throughout Indonesia up until 1940 were those introduced by Japanese fishermen. The Japanese fishermen, using sea-going motor launches, go in all sorts of weather except during an actual typhoon. From fishing grounds nearby and from those 700 miles away they brought fish in good condition to Manila. In a short time numerous Japanese outfits were at work over most of the Philippines, and also in the waters of Borneo, Malaya and throughout the Dutch East Indies.

Albert W. Herre.

Improvement of Fishing Craft and Gear.—Although Madras has developed the fisheries, the two most important aspects of fishing 'craft and equipment' have been neglected.

W. R. Burgess.

All types of craft are needed for the Madras coasts and with a population, such as the province has, trawlers are not recommended. But small craft from 25 ft. sailing and motor to 45 to 50 feet seine and ring net boats are desirable.

Regarding equipment Madras will need to blend their nets with overseas types, so that suitable equipment may be had for their particular type of fishing.

Take for instance, the Rampina net—this net shortened, lightened, balanced and crossed with a Japanese ring net, would be ideal for off-shore operation. Several variations may be made for different parts of the coasts, so that they may be suitable for sardine and mackerel fishing.

Although the Bengal craft are primitive and poor construction, they have been specialized for their individual operation. It would be a gamble to introduce power craft as an economic venture to compete against these craft. If production is to be increased in the rivers and estuaries, it would probably be better to concentrate on stepping up efficiency, transport and marketing facilities by introducing modified equipment, power-tug-*cum*-refrigerated craft and refrigerated transport.

The type of craft which operate the foreshores of Bengal is not a passage maker and is dependent on favourable weather. Much could be done to increase marine food production by introducing new types of craft and

equipment: A properly rigged shoal draft centre-board boat for foreshore work may be worked by a crew of 3 to 5 men and larger types to operate Danish seines and long lines offshore.

FISHERIES RESEARCH.

Stanley W. Kemp: Scientific knowledge essential for the proper conduct of a fishery; Fundamental Research Problems; Need for an Indian Fisheries Research Service; Fisheries Research in the British Colonies; Inland Fisheries Research; Fish Farm Experiments; Fisheries Research Stations; Research Problems of Estuarine Fisheries. *George S. Myers*: Need for systematic work. *Albert W. Herre*: Literature, Publications and Library. *R. W. Burton*: Co-ordination of Research and Extension Schemes; Fishery Catalogues.

Stanley W. Kemp.

Scientific knowledge essential for the proper conduct of a fishery.—Experience in this country (U.K.) has clearly shown that a full knowledge of the biology of fishes—of their rate of growth, length of life, age at sexual maturity, development, migration and so forth—is essential to the proper conduct of a fishery, and that in Bengal practically all this knowledge has yet to be acquired.

Fundamental Research Problems.—On the scientific side you will, first and foremost, always bear in mind the need for acquiring full information on every important species of fish. At present it is I suppose true to say that our ignorance is almost complete. In the first place, by examining very numerous samples from as many localities as possible and at different seasons by measurements and by studies of scales and otoliths, you will want to ascertain essential knowledge on such matters as the rate of growth, the age at sexual maturity, spawning seasons and localities and migrations. Even when the more important information has been acquired you will need to continue the observations, firstly because such work will give early indications of whether the fishery is declining through overfishing (the consequences of which may be utterly disastrous if not detected in time) and secondly because regular and continued work will yield data on annual fluctuations which may in due time afford a basis for fishery prediction. This is essential work which cannot be hurried and which obviously cannot be expected to produce early results, but none the less, regard it as of primary importance. In it there is enough work to keep a large and well-trained staff busy for a very long term of years. As a beginning I think you should if possible start with a small number of carefully selected men working on a few of the most important species. Don't let them get distracted by trying to deal with every kind of fish that comes their way—if they do, you won't get anywhere. Much the best method, as we have found over here, is to have one man for each species—the one species is his subject and you will expect him before long to have the most expert knowledge of it, not only of its ecology, but of its distribution and density in different areas, of the ways in which it is caught and of its importance in the fisheries. Later when the fundamental work has been done and while still keeping a check on it he can tackle another species. In this way you can only deal of course at the beginning with a small number of species, but you will be continually expanding until in course of time you have a comprehensive knowledge.

Need for an Indian Fisheries Research Service.—All the fisheries research people in the country should be incorporated in an all-India research service under the Central Government, while each province should have its own fisheries administration staff. This, I feel sure, is the proper form of organization; it is similar to what we have devised for the Colonies, viz.

a research service directly responsible to the Secretary of State who will have a Fisheries Adviser and a Colonial Fisheries Advisory Committee, while each colony will have its own fisheries administrative service.

The local Governments will constantly need expert scientific advice, but this can always be given, for I assume that as soon as sufficient staff is available at least one member of the Central Research staff will be available in each province. The advantage of this centralized arrangement is that scientific staff will be used properly and will not waste their time, as I think is otherwise inevitable in dealing with administrative problems on which, indeed, they may very likely prove incompetent—for it is to be remembered that they have been selected for their scientific ability and not for administrative capacity. Moreover, local and provincial Governments are usually without any proper appreciation of the value of research. They are incapable of taking the long view, will expect practical results within a single year from any piece of research, however, recondite; and they are in general quite incompetent to control and get the best results from a scientific staff. Though I knew all this well enough before, I have recently been amazed at the extreme difficulty of getting Colonial Governments to understand the most elementary principles of scientific research.

Fishery Research in the British Colonies.—Plans for post-war fishery research both in this country and in the colonies are now being considered. A fishery service for the colonies is being established and fishery stations are contemplated in W. Africa, the West Indies and other places. It is almost certain that fishery research fellowships will be awarded to suitable graduates in science and that special courses of instruction covering all branches of fishery research will be arranged. When this scheme comes into operation you will be able to send some of your people over here to attend the classes, and I feel sure this will prove advantageous. At least one of your men should visit Palestine to look into the details of carp culture.

Inland Fishery Research.—There is, I imagine, a great deal of experimental work to be done before it can be claimed that the best methods for tank culture have been finally ascertained and it is apparent that a well-equipped station for this work, with a very large number of tanks should be started without delay. Similarly paddy-*cum*-fish schemes must be developed by trained scientific staff, though with both lines of work a time should come when the best technique has been discovered and pamphlets for the guidance of cultivators have been issued.

Fish Farm Experiments.—A great part of Bengal is ideally situated for fish farming and I have no doubt at all that by taking appropriate measures the fish supply from this source could be very greatly increased. The various races of the European carp now extensively farmed in Palestine breed very well in ponds and fry can thus easily be obtained in pure culture without the admixture of predaceous species. It might even be worth while seeing how the European carp would do in Bengal. That, however, would be for the future. Your immediate aim will be to set up a fish farm and hatchery. Here you must undertake extensive experiments on a number of different lines. Make sure that the species will not breed in still water; if this is so arrange ponds with a good inflow and outflow and see if the fish will then breed in them, at the same time starting a hatchery for artificially fertilized eggs, which may ultimately prove to be the best way. Find out all you can about the fry which are collected in the rivers and, in particular, whether it is possible to eliminate the young of predaceous fishes and retain only the fry of the species required. In your experimental ponds, which will need to be very numerous, there is much k to be done. Which species is the best, what is the optimum number

for a given volume of water, what is the best way of feeding, how often should the pond be drained and the crop taken and what weight of fish may reasonably be expected from a given area of water? In Palestine the fish are fed on cotton seed residue; this is apparently eaten directly by the fish, while any that remains uneaten goes to increase the plankton content of the water. This is a much easier business than the shallow culture ponds for Entomostraca. It will be worth while seeing if a food stuff similar to cotton seed residue can be found.

Fishery Research Stations.—I think you should aim at establishing two experimental farms for fresh-water fish in places with different conditions, two stations for estuarine fish and one similar station for inshore marine fishes. Of these five stations the fish farms with their experimental ponds, pumping plant, hatcheries and so forth will be much the most expensive. As a beginning at any rate, these stations may be quite small places—little more than offices with rooms set apart for laboratories. The estuarine and marine stations will need a motor research vessel each and those for the estuarine work at least should be sufficiently large to provide sleeping accommodation for the crew and scientific staff. I assume that the men working on Hilsa and prawns will be based on one or other of these stations and that the experimental drying plants will be erected in their vicinity.

Research Problems of Estuarine Fisheries.—On the estuarine fishes, betki, pomphret, mullet and so forth, it does not seem easy to make specific suggestion. Here again our knowledge is deficient. At least four of your staff should concentrate on these important fishes and with more information it should be possible to find ways for improving the fishery. I would not advocate hatcheries until more is known, but it might be worth while making small scale experiments in fish farming in a blind khal in the Sundarbans. Experiments in rearing flat-fish are now in progress in a Scottish loch and appear to be promising; the loch is separated from the sea by sluice gates and the water is chemically enriched. It may be that work on some such lines as these would prove successful in Bengal.

Need for systematic work.—One of the fundamental necessities of modern fishery research is the existence of reliable fishery catch statistics from different localities, and those statistics must be comparable. Lacking the systematic basis, the statistics in Brazil were in hopeless confusion, and one result of our survey will be systematic work on the marine commercial species to enable Brazil to initiate the taking of crude though comparable catch records at the main ports at least. India needs four or five good fish systematists, and I hope you can do something about it.

George S. Myers.

Literature, Publications and Library.—Literature, Library and publications are all very important. It is impossible to carry on research without a library, and equally impossible to maintain productive research without a channel for publication of results.

Albert W. Herre.

A very important corollary of the publication of a scientific journal or research bulletin is the building up of the library of the station or institute. Scientific knowledge is distributed by the world-wide exchange of publications. To buy all the journals would be very expensive and many cannot be purchased, but are only obtainable through exchange. The publication of a suitable journal would be one of the most effective means of maintaining the library in touch with the latest literature and keeping the staff posted on the latest results of experimentation and investigation, both in the field and in the laboratory. A Fisheries Research Institute worthy of the name cannot function without a journal.

Co-ordination of Research and Extension Schemes.—There would probably have to be, all along the Coast Line of India Fisheries Control Stations at selected places such as: Karachi, Surat, Bombay, Ratnagiri, Marmugoa, Karwar, Mangalore, Calicut, Cochin, Tuticorin, Negapatam, Chingleput, Nellore, Coconada, Chicacole. At these places, and perhaps others also, there would be greater or lesser Research establishments; and in this way the necessary organization would be built up as present conditions indicate and in the light of future experience and development.

R. W. Burton.

Always will it have to be borne in mind that hand in hand with research must be the practical development of the fisheries; the improvement of vessels and gear; the improvement of storage and transport arrangements to ensure the maximum results from the nets to the markets; and, betterment of wages and living conditions and general uplift of the fisher people themselves.

Fishery Catalogues.—One of the first necessities is compilation of a comprehensive and accurate list of all the local names of all the Commercial sea-fishes, also the food they prey upon. This list would be in English, with Scientific names in Latin, and vernacular names in the various languages and be completed all along the coast by Districts, or Control Stations, or as may be found best. This list would be necessary to all the Research establishments and to the contractors and headmen of fisher communities, and those in charge of curing yards and so on. It would have to be translated into the various languages in use along the whole coast line. Without such a list there would be much confusion of effort.

I think that there should, if possible, be illustrations of the commercial fishes as a guide to all who have the list in use or for reference. These could be numbered to tally with the list and be arranged on a separate sheet affixed to the list, or as found convenient.

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KNOWLEDGE OF THE ANCIENT HINDUS CONCERNING FISH AND FISHERIES OF INDIA.[1]

I. REFERENCES TO FISH IN ARTHAŚĀSTRA (*ca.* 300 B.C.).

By SUNDER LAL HORA.

(*Received January 30, 1948.*)

INTRODUCTION.

Kauṭilya's [2] *Arthaśāstra* is the earliest known dated work of the ancient Hindus, having been written somewhere between 321 and 300 B.C. The work deals with the art of government, the duties of kings, ministers and officials, and the methods of diplomacy. I have consulted Shamasastry's English translation of the work (2nd Ed., Mysore, 1923) and throughout the article references will be made to the translation.

Mr. M. Venkataramayya, Epigraphical Assistant, Archaeological Survey of India, very kindly tabulated for me all references to fish in Kauṭilya's *Arthaśāstra* and I am very grateful to him for this painstaking work.

RÔLE OF FISHERIES DURING SHORTAGE OF FOOD.

In view of the present food scarcity and particularly of high quality protein food, it is of interest to note that in Book IV, Chapter III, dealing with remedies against national calamities, under Famines, Kauṭilya *inter alia* advises the king to

> 'remove himself with his subjects to seashores or to the banks of rivers or lakes. He may cause his subjects to grow grains, vegetables, roots, and fruits wherever water is available. He may, by hunting and fishing on a large scale, provide the people with wild beasts, birds, elephants, tigers or fish' (p. 254).

It is no unusual coincidence that the Bengal famine in 1943 made the Central and Provincial Governments in India realize the value of developing fisheries and the *Famine Inquiry Commission* in their *Final Report* (Delhi: 1945) laid 'strong emphasis on an increased production of fish as a very important part of the programme for improving the diet of the population'. It may be recalled that early in 1946, even Mahatma Gandhi recommended the catching of sea fish on a large scale by employing naval personnel and craft. At the same time, the Central Government seriously considered the possibilities of importing salted and smoked fish from abroad. Under the 'Grow More Food' campaign, the Central, Provincial and State Govern-

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1 The writer is indebted to Dr. B. C. Law, M.A., B.L., Ph.D., D.Litt., F.R.A.S.B., for giving financial assistance to Sanskrit scholars for collating references to fish and fisheries in ancient Hindu literature in order to enable me to write this series of articles.

Reference is invited to the following two previous articles concerning the same subject:—

'Ancient Hindu Conception of Correlation between Form and Locomotion of Fishes', *J.A.S.B.*, Science, I, pp. 1–7 (1935).

'Sanskrit Names of Fish and Their Significance', *J.R.A.S.B.*, Science. Vol. XIV, No. 1.

2 Kauṭilya is also known as Vishṇugupta and Chāṇakya.

ments are now paying more and more attention to the development of fisheries which had suffered great neglect in the past.

In Book XIII, Chapter V, dealing with the operation of a siege, Kauṭilya advises the reduction of the enemy before the commencement of the siege and among a large number of other measures suggests:

> 'A splinter of fire kept in the body of a dried fish may be caused to be carried off by a monkey, or a crow, or any other bird (to the thatched roofs of the houses)' (p. 468).

This is a significant passage, for it shows that the invading armies in those ancient days carried a supply of dried fish with them and, therefore, the art of processing fish must have been known to those people. A splinter of fire kept in the body of dried fish is not likely to go out since there is always a certain amount of body oil that will come out from dried fish when heated and this will keep the splinter alive. Monkeys, crows and many other birds used to be as fond of fish in those early days as they are at the present time.

Fishery Management.

In the chapter dealing with 'Formation of Villages' (Book II, Chapter I, p. 51), *it is stated that*

> 'the king shall exercise his right of ownership (*svāmyam*) with regard to fishing, ferrying and trading in vegetables (*haritapaṇya*), in reservoirs or lakes (*sētushu*)'.

The reservoirs referred to would appear to be irrigation tanks and it is gratifying that even in those early days they were used for fish culture.

In accordance with the 'Regulation of Toll-Dues' (Book II, Chapter XXII, p. 135), imported commodities were charged one-fifth of their value as toll, but in the case of perishable articles such as flowers, fruits, vegetables (*śāka*), roots (*mūla*), seeds, dried fish and dried meat the toll was one-sixth of the value of the article. With regard to conch shells, the fixation of the amount of the toll was left to the judgement of experts.

The most significant point to be noticed here is that dried fish must have been a regular trade commodity and, therefore, methods of processing fish must have been known in those days.

Among the directions given to 'The Superintendent of Agriculture' (Book II, Chapter XXIV, p. 141), it is stated:

> 'The sprouts of seeds, when grown, are to be manured with a fresh haul of minute fishes and irrigated with the milk of *snuhi* (*Euphorbia Antiquorum*).'

It is interesting to note that small fish of little economic importance as table fish were used as manures and that the high value of fish manures was recognized by the ancient Hindus.

The Superintendent of Slaughter Houses (Book II, Chapter XXVI, pp. 147-148) is enjoined to enforce several regulations concerning fish and other animals. The following are applicable to fish:—

(i) When a person entraps, kills, or molests fish which are declared to be under State protection or which live in forests under State protection (*abhayāraṇya*), he shall be punished with the highest amercement.

(ii) When a person entraps, kills, or molests fish that do not prey upon other animals, he shall be fined $26\frac{3}{4}$ *paṇas*.

(iii) Of fish that have been captured, the Superintendent shall take one-tenth or more than one-tenth as toll.

(iv) Fish in tanks, lakes, channels and rivers shall be protected from all kinds of molestation.

(v) Fish living in forests under State protection shall, if they become of vicious nature, be entrapped and killed outside the forest preserve.

Among the instructions given to 'The Superintendent of Ships' (Book II, Chapter XXVII, pp. 152-153) are the following regarding fishermen:—

(i) Fishermen shall give one-sixth of their haul as fees for their fishing licence (*naukāhāṭakam*).

(ii) Fishermen shall be exempted from payment of fees for fording or crossing rivers at any time and place.

It will be worth while for Fishery Officers to examine the above regulations carefully and to compare them with the existing rules and regulations in their respective areas. It will be seen that the fishing fees charged by the Zemindars and other private owners of fisheries are far in excess of one-sixth of the haul. Usually it is one-half and sometimes even up to two-thirds. The fishermen are nowadays subjected to such an amount of rent or other imposts that they can just merely exist by carrying on their profession. It will be necessary to lighten their taxation burden in order to improve the social status and economic standard of fishermen.

Rendering Fishes Poisonous.

In Book XIV, Chapter I (pp. 478, 479), Kauṭilya deals with secret means to injure an enemy and suggests the following mixture and treatment for rendering fishes poisonous:—

'The mixture prepared from the flowers of *bhallātaka* (*Semecarpus Anacardium*), *yātudhāna* (?), *dhāmārgava* (*Achyranthes aspera*) and *bāṇa* (sal tree), mixed with the powder of *elā* (large cardamom), *kākshi* (red aluminous earth), *guggulu* (bdellium), and *hālāhala* (a kind of poison), together with the blood of a goat and a man, causes biting madness.

'When half a *dharaṇa* of this mixture, together with flour and oil-cakes, is thrown into water of a reservoir measuring a hundred bows in length, it vitiates the whole mass of water; all the fish swallowing or touching this mixture become poisonous; and whoever drinks or touches this water will be poisoned.'

There is a great deal of scientific knowledge in the practice mentioned above. In the first place, a distinction is made between poisoning and rendering fishes poisonous. In carrying out the above treatment, the fish do not die but their flesh becomes poisonous so that whoever eats it is poisoned.

Fishery Officers will recall some parallel cases. When carps are fed on silkworm pupae, their flesh becomes poisonous, so the practice is to condition such fishes for three or four days before sale. It is known that certain fishes become poisonous during certain periods of the year and investigations have revealed that this is due to the fact that during these periods fishes feed on certain types of poisonous algæ. It is known to fish culturists that the quality of the food determines the taste and flavour of the fish.

There are several kinds of herbs, fruits, barks of trees, etc. which are used for poisoning or stupefying fishes for their capture, particularly from rocky streams. The object of the treatment recommended by Kauṭilya is not the capture of the fish or to injure them in any way but to render their flesh poisonous so as to render them poisonous for the enemy.

One thing is clear from Kauṭilya's account that fish was cultured in reservoirs and that it used to be captured for human consumption. Further, during the movement of an army, fresh fish used to be a regular item of ration whenever available.

Miscellaneous Uses of Fish.

Fish forms one of the ingredients of two other mixtures used for doing injury to an enemy (p. 476). These are as follows:—

'The smoke caused by burning the powder of *śatakardama* (?), *uchchiṭiṅga* (crab), *karavīra* (*Nerium odorum*), *kaṭutumbi* (a kind of bitter gourd) and fish, together with the chaff of the grains of *madana* (?) and *kodrava* (*Paspalam scrobiculatum*), or with the chaff of the seeds of *hastikarṇa* (castor oil tree) and *palāsa* (*Butea frondosa*), destroys animal life as far as it is carried off by the wind.'

'The smoke caused by burning the powder of *pūtikīṭa* (a stinking insect), fish, *kaṭutumbi* (a kind of bitter gourd), the bark of *śatakardama* (?) and *indragopa* (the insect cochineal), or the powder of *pūtikīṭa*, *kshudrārāla* (the resin of the plant *Shorea robusta*) and *hēmavidāri* (?), mixed with the powder of the hoof and horn of a goat, causes blindness.'

Fish Metaphors.

Book I, Chapter XIII, p. 24.—People suffering from anarchy are likened to the proverbial tendency of a large predatory fish swallowing smaller ones (*mātsyanyāyābhibhūtaḥ prajāḥ*).

In this connection reference is invited to the Sanskrit names *Jhasha* and *Mina* for fish discussed in an earlier article. A predatory fish chases a shoal of small fishes, captures some and scatters the rest. When chasing them into shallow waters, it splashes water with its fins.

Book II, Chapter IX, p. 77.—

'Just as fish moving under water cannot possibly be found out either as drinking or not drinking water, so government servants employed in the government work cannot be found out (while) taking money (for themselves).'

Though there is a well-known saying 'to drink like a fish', scientifically Kauṭilya is right in saying that it is not possible to determine whether a fish drinks water or not as we do. His analogy of government servants taking bribes is very appropriate indeed.

General Observations.

Book I, Chapter XXI, p. 46.—Kauṭilya enjoins a king for his personal safety to 'get into such water as is free from large fishes (*matsya*) and crocodiles'. Here probably warning is given against sharks frequenting the mouths of rivers and certain catfishes.

Book III, Chapter IV, p. 194.—'It is no offence for women to fall into the company of actors, players, singers, fishermen, hunters, herdsmen, vintners, or persons of any other kind who usually travel with their women.'

Conclusion.

From the passages quoted from Kauṭilya's *Arthaśāstra*, it is evident that even in the dim past ages, fishery was a well-established industry in India and that fish was relished as an article of diet. During famines or other national calamities, greater use was made of fish to tide over food shortages. Fishermen were charged low licence fees (one-sixth of the value of the catch) for catching fish and were given concessions for fording or crossing rivers. Fish processing (dry fish and fish manures) was known in those days and fishery products were charged a low rate of toll tax. The ancient Hindus possessed a considerable general knowledge of the habits of fishes and used that knowledge to practical purposes or in using metaphors.

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Indian Experience Regarding Protection of Fish and Wildlife in Reference to Hydro Power and other Water Uses

by

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INTRODUCTION

INDIA has suffered great losses in neglecting the proper management of her Fish and Wildlife resources in the past and is still suffering through the apathy of the public. In the case of fish, the measures that have hitherto been adopted, such as the construction of fish-ways and fish-ladders in dams and weirs, were not based on knowledge of the migratory movements of the species concerned, so no comparison can be instituted between their economic costs and benefits. The costs of such protective works have undoubtedly been heavy in the past, as compared with benefits, if any, derived from them. The backward state of Indian Fisheries and the ineffective methods of fishing have so far saved the river fisheries of India from utter ruin.

In the case of wildlife, there are laws and regulations (Anon, 1941-42), but unfortunately, with the exception of reserve forests, they have not been strictly enforced anywhere. "Forgetfulness, Indifference, Ignorance and Greed for Gain" are thus sealing the fate of Fish and Wildlife in India, unless immediate well-concerted, integrated and thoroughly planned steps are taken to stop wanton destruction.

FISHWAYS AND OTHER PROTECTIVE DEVICES FOR FISH

The problems of obstructions, which prevent the upstream migration of commercially important food fishes or permit the streams below the obstructions to dry up for a part of the year, are now regarded as some of the most important phases of fisheries work in advanced countries. In India, the harmful effects of dams on the fisheries of the South Indian rivers were realized as early as 1867, and Day (1873) reported that narrow under-sluices, such as exist in the Punjab, U.P., Bihar and Madras, were ineffective, whereas weirs with wide under-sluices, such as exist at Cuttack (Orissa) and Midnapore (Western Bengal), did not impede the ascending fish when they were open. He found fish trapped in irrigation canals and suggested remedial measures.

Day's proposal to construct fishways for the movements of Hilsa was abandoned as impracticable, but no further action seems to have been taken till Wilson and Raj again took up the matter in Madras. They (*vide* Raj 1917) opined that pisciculture was the only satisfactory solution of the Hilsa problem and accordingly a hatchery was set up at Coleroon. Though the practicability of artificially hatching Hilsa eggs has been established beyond doubt, the rearing of the delicate larvae has not yet proved successful.

Khan (1940) and Rai (1948) in the Punjab and Sundara Raj (1941) and Devanesen (1942) in Madras have commented on the harmful effects of dams on the fisheries of the rivers and the ineffectiveness of the existing fish-passes. After conducting investigations on the effect of Mettur Dam on fisheries, Raj concluded that

> "in India fish passes are scarcely ever necessary and even when practicable are not economical. There is, however, no doubt that dams seriously affect fisheries, as has been proved at Mettur, otherwise than by obstructing the free passage of fish, and all remedial measures possible for wise administration legislation and culture should be sought and practised if the baneful effects of dams on fisheries are to be circumvented".

Since 1941, the writer has been impressing the Indian Council of Agricultural Research, Central Water Power, Irrigation and Navigation Commission and the Central Board of

the necessity of undertaking investigations on the conservation of river fisheries in relation to the big programme of construction of a large number of multi-purposes dams in the country with the following results :—

1. In all dams construction projects, there is a provision for the investigation of fisheries and the construction of fish protective works.

2. The Indian Council of Agricultural Research sanctioned a scheme in 1946 for two years "for investigation into the bionomics of Indian migratory Fishes with a view to standardise designs for fish-passes". Unfortunately, the work under the Scheme had to be interrupted and instead the Technical Assistant carried out an Economic Fishery Survey of the Kosi River. With regard to the construction of the 700 feet high Kosi Dam, he came to the same conclusions, as did Raj, that (*i*) construction of any fish-pass will be uneconomical, (*ii*) if later experience demands any measures of fish conservation, lifting arrangements for fish assembled below the dam would be more effective, (*iii*) possibilities of culturing Hill Barbels and Labeos in the reservoir should be investigated, and (*iv*) methods of capture and marketing of fish will need looking into as soon as the reservoir is filled up and the fisheries is established.

3. The Research Committee of the Central Board of Irrigation has desired that "irrigation research stations should undertake work on fish passes by associating fishery scientists with them in their work".

With the exception of the Mettur Dam, where an outlet was aligned with a view to provide a passage for the free exchange of fish populations above and below the dam, no effective construction regarding the conservation of river fisheries has yet been devised in India. Though the fish-passes constructed during the last decade are made fairly wide, baffles are provided at suitable intervals and angles to break the force of the current and the successive steps are not made higher than about a foot, fishery officers have not found any marked improvement in their effectiveness.

COSTS AND BENEFITS OF CONSTRUCTING FISHWAYS, ETC.

In the matter of dam constructions, there is great conflict between the needs of power and irrigation on the one hand and conservation of river fisheries on the other. The Secretary of the Central Board of Irrigation observed :

"Five cusecs discharge yields 10,000 *maunds** of wheat ; will the same discharge through a fish ladder increase the fish productivity of the river to ensure the same or greater nutritional value".

This question (Hora 1948*a*) was posed at the Joint Meeting of the Fish and Nutrition Committees of the FAO and opinion was elicited that whilst a calculation of the relative values of fish-lost against cereal-gained would be difficult to calculate, measures could be adopted to reduce, if not eliminate, the adverse effect on fish. In addition, other methods would lead to increase and improvement of fish populations so as to give increased yield of aquatic products. There was recognition of the need for integrated research in connection with this problem.

The Government of India have now felt it necessary to carry out intensive integrated research in connection with irrigation development schemes having direct or indirect bearing on fish production. The snag, however, lies in the fact that projects for multipurposes dams are going ahead whereas there are very few fishery biologists who could advise on suitable conservation measures to be taken in connection with each project. Unfortunately even these few biologists have not yet been harnessed to undertake investigations on this very important problem.

UTILIZATION OF WATER CONTROL PROJECTS FOR WILDLIFE PROTECTION

In the case of wildlife, the neglect is till more marked. There are at present 25 main weirs and 105 high dams in existence in India and Pakistan, and quite a large number of other dams and weirs are either under construction or investigation. So far as the writer is aware, no wildlife conservation scheme has been integrated with any of these water-control projects. In the Tennessee Valley, of which one hears quite a lot in India, the TVA has reserved land for 16 state parks, 57 country and municipal parks, 37 public landing and picnic areas, 52 group camp sites, 58 private cabin colonies and 138 fishing camps and boat docks. In addition, the most scenic portions of the shore line are protected against spoilation. In all such areas, wildlife is protected. Thus the term "multiple use", as applied to TVA reservoirs,

* approximately equal to 82 [illegible]

not only use of the water for flood control, navigation, and power production, but also the utilization of biological resources associated with water.

The teachings of Hinduism, Buddhism and Jainism had hitherto provided protection to wildlife in India but now it is different. This, combined with the population pressure on land, has totally wiped out larger animals and beautiful birds from many districts of India. Laws and regulations for the protection of wildlife do exist but, in the absence of strong public opinion, these are ineffective. Though the old religious beliefs gave wildlife protection in the past, they also created indifference and apathy towards wildlife. Thus in India, it is hardly realized, even among a majority of the administrators, that Wildlife is a national and natural asset which, if it is ever lost, can never be replaced. Burton (1948) has now launched a vigorous campaign for the preservation of wildlife with the support of the Bombay Natural History Society but, as the masses are illiterate, it will take a long time to create public opinion, without which wildlife cannot be saved and preserved in perpetuity. In the meantime, Central Provincial and State Governments can establish national parks in conjunction with the water-control projects so as to ensure the continuity of the magnificent heritage of Indian Wildlife.

ADMINISTRATION OF FISH AND WILDLIFE BENEFITS OF WATER PROJECTS

The fishery and wildlife interests have been neglected because fish and wildlife experts have often not had the opportunity of representation on planning boards and administrative agencies concerned with water use. The Waterways engineers responsible for the construction of dams do not allow sufficient spill because the cost of keeping the streams alive may be difficult to justify on economic grounds in terms of crop production or electric power. However, advantage can still be taken of the impounded water by using it for the culture of fish. If, somehow, we can regulate the run-off, stream flows will be more constant and there will be more favourable environment for the fish. If adequately developed and properly regulated, multiple use of water, even if due for production of power or irrigation of crops, can still produce large quantities of fish (Hora 1948b). The most important thing is that the engineers and fishery biologists should be brought together at the outset and not for a *post mortem* investigation as has been the case in the past.

CONCLUSIONS

From the above the following main problems can be set out :

(*i*) An investigation into the nautical properties of the Indian migratory fishes, in order to enable the engineers to devise suitable fishways or other protective devices.

(*ii*) Devising mechanical or electric screens at the heads of canals to prevent young fish from entering them.

(*iii*) Surveys of fish and fisheries of rivers before any attempt is made to design a fish-pass.

(*iv*) Thorough investigation to be made jointly by a qualified engineer and a qualified fishery biologist of the fish-passes already in existence so as to assess their economic value.

The waterways engineer and the fishery biologist should thus pool their knowledge so as to devise effective measures for the protection of fish in connection with each water project. India possesses capable engineers but lacks biologists of the suitable calibre. It is necessary, therefore, that immediate facilities should be provided for the training of such biologists in India. Those, who have already gained local experience of the work, should be sent abroad to study the technical developments, in this line and their likely application to Indian conditions.

On the administrative side, pro
isolated pools below the dams, especially during dry seasons ; stoppage of commercial fishing below dams and the protection or salvage of young fish in
...es of the rivers and irrigation canals
...ctical legislative measures and the means to enforce them.

For a country of the size of India, with its diversity, huge population and immense natural resources of fish and wildlife, it seems essential, at least highly desirable, that the management of fish and wildlife resources should be in the hands of a special department of the Ministry of Interior, when such is set up. Piece-meal measures and isolated attempts without any co-ordinating authority have not been successful and cannot possibly make any lasting impressions on this vast and inter-related problem.

ACKNOWLEDGMENT

In preparing this note, I received great help from Lt. Col R. W. Burton and Mr. L. R. Fawcus concerning protection of wildlife in India ; and

from Dr. B. Sundara Raj, Fisheries Adviser to the U. P. Government ; Shri P. R. Ahuja, Central Board of Irrigation, and Shri H. L. Vadera, Central Waterways, Irrigation and Navigation Commission, regarding the present position of fish-ways and fish-passes in India.

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SUMMARY

Attention is invited to the vanishing assets of India in regard to fish and wildlife. It is shown that the traditional and religious beliefs that afforded protection to these resources are now crumbling down. As creating public opinion in favour of fish and wildlife protection may take a long time, suggestion is made that Central, Provincial and State Governments should establish national parks in conjunction with water-control projects and enact practical legislative measures with means to enforce them. The necessity of creating a Fish and Wildlife Department is indicated.

On the technical side, a majority of fishways, hitherto constructed without any consideration to the nautical properties of the Indian migratory fishes, have proved ineffective. The utility of setting up hatcheries for the Indian Shad is also problematical. Utilization of impounded waters for increasing fish supply through judicious cultural operations, especially in warmer parts, seems to provide possibilities of augmenting fish supplies and of circumventing the baneful effects of dam-constructions.

The need of concerted, integrated and thoroughly planned measures is stressed right from the commencement of any water-project scheme. Lack of suitable fishery personnel for this integrated work is indicated and their training in India under the conditions in which they will have to work is recommended.

From the Journal of the Royal Asiatic Society of Bengal. Letters.
Volume XVI, No. 1, 1950

KNOWLEDGE OF THE ANCIENT HINDUS CONCERNING FISH AND FISHERIES OF INDIA

2. Fishery Legislation in Asoka's Pillar Edict V (246 B.C.)[1]

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Contents

Introduction

Though this is the second[2] article of the series started in 1948, in fact this is the fourth[3] article in which a critical review is given of the knowledge of ancient Hindus concerning the fish and fisheries of India. Dr. B. C. Law's financial assistance enabled the writer to engage some Oriental scholars for collating references to fish and fisheries in ancient Hindu literature in order to write this series of articles, but I regret it has not been possible for me to devote much time to this work in spite of the fact that a considerable amount of partly digested material is now available for my study.

In the present article, an attempt is made to elucidate the significance and importance of the injunctions laid down by Asoka concerning the catching of fish in his benevolent laws. I have made every attempt to complete this article as a dedication to the Republic of India when it comes into existence on the 26th January, 1950, for it seems to me that we may

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[1] I am grateful to Dr. B. C. Law for giving me the correct date of the Pillar Edict V. Asoka ascended the throne in 272 B.C. (*vide* V. A. Smith's *Early History of India*, 4th ed., pp. 206-207). The Pillar Edict V was put up when he had ruled for 26 years.

[2] For the first article on 'References to Fish in Arthaśāstra (*ca.* 300 B.C.)' see

[3] For the two earlier artic[illegible]ent Hindu Conception of Correlation between [illegible]d Locomotion of Fishes', *J.R.A.S.B. Sci.*, I, pp. 1–7 (1935) and 'Sanskrit Names and their [illegible]ce', *J.R.A.S.B. Sci.*, XIV, pp. 1–6 (1948).

have to go back to the Asokan period, not only for an Emblem of *Chakra* on our National Flag and Asoka's Capital *Motif* for the official seal but also for the conduct of our day-to-day life.

ASOKA AND HIS INSCRIPTIONS

In order to supply the necessary background for the readers of this article, Shri S. K. Saraswati[1], Librarian of the Royal Asiatic Society of Bengal, very kindly supplied to me the following note concerning Asoka and his Inscriptions:—

'The main sources of our knowledge about Asoka and his activities fall into two categories—Literary and Archaeological. Of these, the latter, consisting of Asoka's own inscriptions, constitutes the direct source of his history. In his inscriptions the king is styled as *Devānaṁpiya Piyadasi rājā* (*lājā*), *i.e.*, 'King Priyadarsi, the beloved of the gods'. The identity of this king with Asoka, suggested long ago, has been proved beyond doubt by the discovery of the Maski version of the minor Rock edicts which substitutes the name Asoka for Piyadasi.

Inscriptions of Asoka have been found engraved on rocks, separate stone block, stone pillars and in caves. Except the last they have been designated as *dhammalipis* translated as "edicts of the law of piety (morality)". Those on rocks have been divided into three broad categories:

(*a*) Fourteen Rock Edicts in seven or eight (if the Sopara version of the Edict VIII is taken to imply the existence of thirteen others at that place) recensions.
(*b*) Two Rock Edicts separately incised at Dhauli and Jaugada, each in two recensions.
(*c*) One minor Rock Edict in ten recensions.

Of the inscription on stone block, the Royal Asiatic Society of Bengal has the Calcutta-Bairat Edict enumerating the sacred texts of the doctrine.

The Pillar inscriptions fall into two groups:

(*a*) Seven Pillar Edicts, the first six in six recensions with the seventh on the Delhi-Topra pillar.
(*b*) Minor Pillar Edicts—
  1. One schism Edict in three recensions.
  2. Queen's Edict in one recension.
  3. Two votive or commemorative pillar inscriptions.

These inscriptions are of outstanding interest for a study of Asoka as herein we can trace the successive stages of the working and outpourings of the mind of Asoka, who has been regarded as 'one of the greatest personalities of world history.'

ASOKA'S PILLAR EDICT V

Asoka's Pillar Edict V, which shows his *Dhaṃmaniyama* or regulation of piety, has been found without any textual variation from six places, namely, Topra (90 *kos* from Delhi on the direct line between Ambala and Sirsava); Mirat, U.P.; Radhia (= Lauriya), Champaran Dist., N. Bihar; Mathia, 15 miles N.W. of Betiya, Champaran Dist., N. Bihar; Rampurva, 32 miles N.W. of Betiya, Champaran Dist., N. Bihar and Kosam, Allahabad, Dist., U.P. It deals with the regulations for the protection of many varieties of animals and the following is its free translation after Hultzsch[2]:—

'King Devānāṁpriya Priyadarśin speaks thus:

(When I had been) anointed twenty-six years, the following animals were declared by me inviolable, *viz.* parrots, mainas, the *aruṇa*, ruddy geese, wild geese, the *nandī-*

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[1] I wish to record here my sincere thanks to Mr. Saraswati for his help in elucidating several unintelligible points in the translations of Asoka's Inscriptions.

[2] Hultzsch, E.—Inscriptions of Asoka in *Corpus Inscriptionum Indicarum*, I, p. 128 925).

mukha, the *gelāṭa*, bats, queen-ants, terrapins, boneless fish, the *vedaveyake*, the *Gaṅgā-puputaka*, skate-fish, tortoises and porcupines, squirrels(?), the *srimara*, bulls set at liberty, iguanas(?), the rhinoceros, white doves, domestic doves, (and) all the quadrupeds which are neither useful nor edible.

Those (she-goats), ewes, and sows (which are) either with young or in milk, are inviolable, and also those (of their) young ones (which are) less than six months old.

Cocks must not be caponed.

Husks containing living animals must not be burnt.

Forests must not be burnt either uselessly or in order to destroy (living beings).

Living animals must not be fed with (other) living animals.

Fish are inviolable, and must not be sold, on the three Chāturmāsīs (and) on the Tishyā full-moon during three days, (*viz.*) the fourteenth, the fifteenth, (and) the first (*tithi*), and invariably on every fast-day.

And during these same days also no other classes of animals which are in the elephant-park (and) in the preserves of the fishermen, must be killed.

On the eighth (*tithi*) of (every) fortnight, on the fourteenth, on the fifteenth, on Tishyā, on Punarvasu, on the three Chāturmāsīs, (and) on festivals, bulls must not be castrated, (and) he-goats, rams, boars, and whatever other (animals) are castrated (otherwise), must not be castrated (then).

On Tishyā, on Punarvasu, on the Chāturmāsīs, (and) during the fortnight of (every) Chāturmāsī, horses (and) bullocks must not be branded.

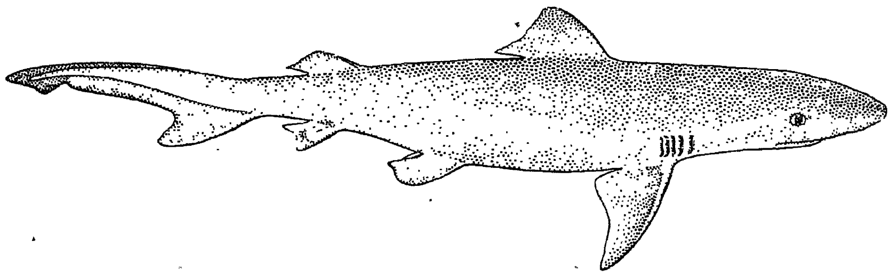
Until (I had been) anointed twenty-six years, in this period the release of prisoners was ordered by me twenty-five (times).'

Five varieties of fish or fish-like animals are included in this Edict. I shall discuss here the probable identity of these fishes as there is a considerable controversy among Oriental scholars on this point. Throughout this article, I shall refer to the translation and glossary as given by Barua [1], the most recent work on the subject. The five species of fish in this Pillar Edict are (i) *Anaṭhikamachhe*, (ii) *Vedaveyakẹ*, (iii) *Gaṁgāpupuṭake*, (iv) *Saṁkujamachhe*, and (v) *Kaphaṭasayake*. I shall consider each one of these separately, but as a general background it must be remembered that the ancient Hindus 'knew a great deal about the external features and habits of a variety of freshwater fishes of the Indo-Gangetic Plain' (Hora, *op. cit.*, p. 6, 1948).

Identification of Fishes

Anaṭhikamachhe

Literally meaning 'the boneless fish'. The Oriental commentators have surmised it to mean 'The prawns or shrimps, the jelly-fish, and the



TEXT-FIG. 1.—*Anaṭhikamachhe*, the boneless fish = a Shark.

Lateral view of the Gangetic Shark, *Carcharhinus gangeticus* (Müll. & Henle).

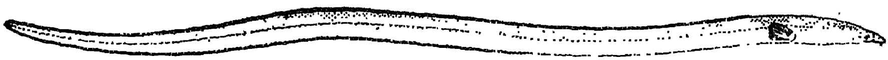
star-fish are typical examples of boneless or invertebrate fishes' (*Anasthikamatsya*). From a scientific point of view, there is lot of confusion of

[1] Barua, B. M.—*Inscriptions of Asoka*. Part II, Translation, Glossary, and General Index, pp. 358–374 (University of Calcutta, 1943).

thought in the above commentary. Vertebrates or broadly speaking Chordates, some of which are worm-like (*Balanoglossus*) or jelly-fish-like (Ascidians) animals, are distinguished from the invertebrates by the possession of (i) a dorsal tubular nervous system as opposed to a ventral solid nervous system, (ii) a dorsal supporting rod, the notochord, which is replaced by vertebrae in the vertebrates, and (iii) perforated pharynx for respiration. Among fishes, there are two main divisions, Cartilaginous or Boneless fishes (Elasmobranchii) and Bony fishes (Teleostei). In the former category are included the Sharks, Rays, and Skates. In their general appearance, Skates are not fish-like and are, therefore, mentioned separately in this Pillar Edict. Knowing the keen power of observation and precision of thought of the ancient Hindus, I feel convinced that in *Anaṭhikamachhe* reference is made to Sharks, some of which ascend rivers for considerable distances into fresh waters.

Vedaveyake

According to Barua (p. 358), 'The name is a matronymic from *vedavā*, Sk. *vidravā*, meaning something "easily eluding the grasp" (Dr. B. C. Law informs me that 'some think of something without a hood, eel').' He comments that 'In the alternative, the name may be equated with *vijapilaka*, which means eels or eel-like fishes that live in mud (*paṁkagāḍakaḥ*, *brahmī*), probably the cylindrical snake-headed eels prohibited in the law books'. His second comment is that 'Assuming that *Vedaveyake* is a scribe's error for *Chedaveyake*, the intended fish may be identified with *Chitravallikaḥ* or *pāṭhīna* (*silurus boalis*, a sheet-fish).'



TEXT-FIG. 2.—*Vedaveyake*, something easily eluding grasp = an Eel.
Lateral view of the common estuarine eel of the Gangetic Delta, *Pisoodonophis boro* (Hamilton).

When discussing the general implications of this law, I shall show that the *Boali* sheet-fish (*Wallago attu*), a prized food fish, could not be intended in *Vedaveyake*, but eels would correctly represent what may have been meant. These serpent-like fishes live in mud and are very slimy and, therefore, easily elude the grasp by slipping through the hand. There is an English proverb also to the same effect—'as slippery as an eel'. Those, who may wish to know more about the ecology and bionomics of eels, may see two articles[1] published in the *Journal* on the Boro-eel of the Sundarban estuaries.

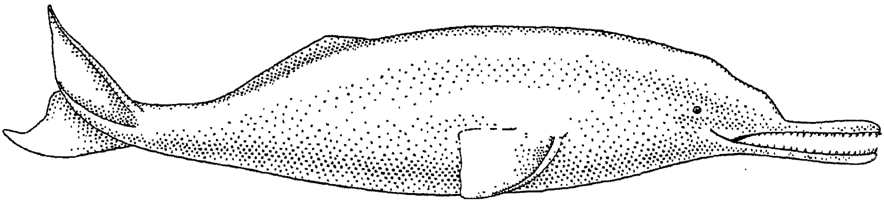
Gaṁgāpupuṭake

Most of the Oriental scholars have not identified this fish but Barua (pp. 358-359) comments:

'The Sanskrit equivalent of *pupuṭaka* is either *puppuṭaka*, *kukkuṭaka* or *pipīṭaka*. Presumably this is the name of a kind of fish. Had it been the name of a bird, it would

[1] Hora, S. L.—A note on the Biology of the Precipitating Action of the Mucus of Boro Fish, *Pisoodonophis boro* (Ham.). *J.A.S.B.* (N.S.) XXIX, pp. 271–274 (1933); Raychaudhuri, S. and Majumdar, B.—A note on the Chemistry of the Precipitating Action of Slime Water obtained from *Boro* Fish, *Pisoodonophis boro* (Ham). *J.A.S.B.* (N.S.) XXIX, pp. 275–283 (1933).

have been easy to identify the *gaṁgāpupuṭake* with *gaṁgākukkuṭake*, *gaṁgāchillī*, *jalakukkuṭī*, *gāṅgchil* or black-headed gull. If it be the name of a fish, as it undoubtedly seems to be, there is nothing in Pali, Prakrit or Sanskrit to correspond to it. In



TEXT-FIG. 3.—*Gaṁgāpupuṭakė*, fish-like creature having a lumpy body = the Gangetic Dolfin.
Lateral view of the Freshwater Indian Dolfin, *Platynista gangetica*.

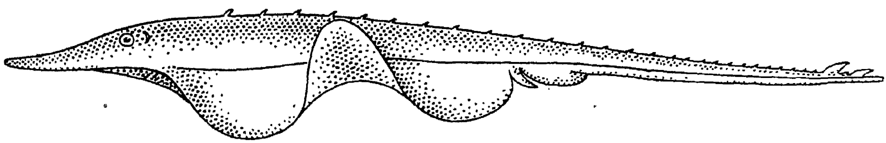
Sanskrit the name *gaṅgāṭeya* is applied to prawns or shrimps. The word *puppuṭaka* may be taken to mean a fish or fish-like creature having a swollen or lumpy body, and this may lead one to think of porpoises. And *gaṅgākukkuṭaka* may be taken to mean the flying fish. The word *pipītaka* means something which is terribly hungry and thirsty. But this leads us nowhere.'

I think in the identification of this animal, the meaning of the word *puppuṭaka* as a fish-like creature having a swollen or lumpy body is very significant. In the general context of this law, I feel almost certain that it refers to the Indian freshwater porpoise, *Platynista gangetica*.

Saṁkujamachhe

The literal translation of the above name would be a 'Contracting fish: (Sanskrit: *Sam Kuc* or Contract), but Barua (p. 359) in his comments states'

'The appropriateness of this rendering is open to doubt. The Amarakosha-Ṭīkā applies the name *śaṁkocha* to an aquatic animal (*jalajantu*) called *śaṅku* in the Amarakosha, Pātālavarga, while in Bengali the skate fish is called *śākach*. The skate is just a species of ray fish (flat and cartilaginous) allied to shark. In Chittagong dialect,



TEXT-FIG. 4.—*Saṁkujamachhe*, a contracting fish = a Skate.
Showing wave motion in the fins of a Skate (after Breder).
The fish is capable of moving by wave-like contracting and expanding movements of the fins themselves. The waves travel at right angles to the longitudinal axis of the body.

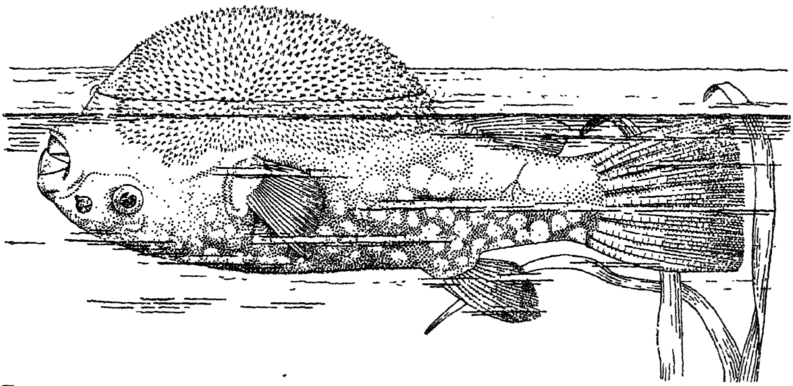
the name *hāñach* (*śākach*) applies to a flat, circular, lumpy in the upper part and whip-tailed variety of ray fish. Monmohan Chakravarti draws attention to *saṅkuchi* in the Bhojaprabandha.'

The movement of a ray is by the alternate contraction and expansion of its body as shown in the accompanying illustration and I think in this name reference is made to skates and rays, some of which ascend into fresh waters for long distances. The name indicates that the ancient Hindus were fully conversant with the mode of locomotion adopted by skates and rays in moving from one place to another.

Kaphaṭasayake, -seyake

Oriental scholars have treated this name as a collective name for tortoises and porcupines, (*kamaṭha-śalyakam*), but Barua's commentary is as follows:—

'This is unacceptable, first, because other names in the list stand for a single species or group of creatures; and secondly, because it is difficult to equate *Kaphaṭa* with *kamaṭha*, and *sayaka*, *seyaka*, with *śalyaka*.[1] We have in the edict *tuphe* for *tumhe*, whereas here the Sanskrit equivalent is *kamaṭha*, and not *kamhaṭha*. Similarly we have *kayāne* for *kalyāṇam* but nowhere *keyāne*. On the other hand, both *-sayaka* and *-seyaka* may be equated in Pali with the Sanskrit *-śāyin*, *e.g. guhāsaya*, *gabbha-seyyaka*, *uttānaseyyaka*. So the name must be constructed as "*kaphaṭa*"*-sayi*, "sleep-feigning". As examples of sleep-feigning animals, one may mention the crocodiles and alligators that are not eatable according to the law-books. The fact which goes



TEXT-FIG. 5.—*Kaphaṭasayake*,—*seyake*, a sleep-feigning fish = a Puffer or Porcupine fish.

The freshwater Indian Puffer, *Tetraodon* (*Chelodon*) *patoca* (Hamilton), feigning sleep.

When frightened, these Blow fishes gulp in air and are able to inflate themselves hard, baloon-like. They then turn upside down and float helplessly, feigning death.

against the identification of *kaphaṭasayake*, *-seyake* with tortoises and porcupines is that the meat of these two five-toed quadrupeds is not forbidden in the ancient law-books of the Brahmins, and secondly, the embargo is already laid on *duli*.'

The sleep- or death-feigning porcupine fishes which should not be eaten are the Globe-fishes of the family Tetraodontidae, some of which are

[1] A contrary view, however, is held by Prof. S. K. Chatterji to whom I am indebted for the following note :

'*Kaphaṭa* and *seyaka*, *pace* the late Dr. Barua, cannot mean anything except "tortoise" and "porcupine". These are well-attested words, and there is no difficulty in the context. *Kaphaṭa* <**kamhaṭa* <**kasmaṭa* can very well be a variant in the vernacular of a probable non-Sanskritic word which has been borrowed in Sanskrit as *kamaṭha*. *Śalyaka seyyaka* (as here; the word is written 𑀲𑁂𑀬𑀓 =*seyaka*, but was unquestionably pronounced as *seyyaka* in Asoka's time) >*sejjaa* in later Prakrit, whence we have an Old Bengali **señja*, with normal intrusive nasal turning *-jj-* into *-ñj-*; and from this **señja* we have Bengali *sẽjā* सैंजा as in *sẽjā-rū* सैंजारु, 'porcupine', spelt also *sā̃jāru* साँजारु, and found in Chittagong as *hẽzā* हैंजा, with proper East Bengal change of *s h* and *j z*; (*ru* is a common affix from old Indo-Aryan *rūpa*; cf. *gōrū gōrūpa*). In fact, *seyaka*, i.e., *seyyaka* for *śalyaka*=Bengal *sẽjā* सैंजा, *hẽzā* हैंजा is one of the pivot words demonstrating the Eastern character of the court language of Asoka.'

found in our fresh waters. They possess a hide-like skin beset with porcupine like spines and when irritated or in danger swell up like a balloon and float upside down feigning death. Probably the fish referred to is the common Gangetic form *Tetraodon cutcutia* Hamilton.

Significance of Protection

From the above discussion, it seems probable that the species of fish referred to in the Pillar Edict V belong to the following kinds:—

	Anaṭhikamachhe		Sharks, boneless fishes.
	Vedaveyake		Eels, fishes easily eluding grasp.
	Gaṁgāpupuṭake		Porpoise, fish-like animal with a lumpy body.
	Saṁkujamachhe		Skate or Ray, fishes moving by contracting and expanding their bodies.
5.	*Kaphaṭasayake*	=	Globe-fish, fish like a porcupine and feigning death when in danger.

These varieties of animals are declared inviolable under the law and we shall now seek the reason why. Barua (p. 355) gives the following explanation:—

'Although motivated by the spirit of *ahiṁsā* or *avihiṁsā*, Aśoka's was not an idealistic or utopian scheme, which was not enforceable under the law. He was guided in this matter, particularly with reference to all quadrupeds, by this two-fold consideration: *ye paṭibhogaṁ no eti na cha khādiyati*, "that do not come into man's use, nor are eaten by men".'

It will be seen from the above that Asoka's purpose was to put a stop to unnecessary killing or torture of undesirable creatures. Even judged by modern religious beliefs among the Hindus, when several old traditional practices have crumbled down already, there is a strong prejudice against eating the flesh of the five varieties of animals enumerated above. There are, however, sound reasons in certain cases. For instance, Globe-fishes and their allies are poisonous and should not be eaten. Unless properly treated, the flesh of Sharks, Rays, and Skates is bitter to taste and gritty on account of the deposition of uric acid crystals in their flesh. The Gangetic Porpoise is revered among the Hindus of the Indo-Gangetic Plain and its flesh is not eaten. With the exception of certain parts of South India, eels are not eaten on account of their strong resemblance to snakes. It would thus appear that the present-day prejudices of not eating these fishes are as old as the Asoka period. The law seems to have been enacted to prevent people from eating these harmful or undesirable animals. It is absolutely correct, therefore, to say that those animals were declared inviolable which 'do not come into man's use, nor are eaten by men'.

Barua (pp. 362-363) gives general rules laid down in the law-books of the Hindus for the guidance of the Brahmins in the matter of eating fish as follows:—

'As for fishes, Vasishṭha and Āpastamba allow all but the *cheṭa*. Bodhāyana permits the eating of the *silurus boalis*, the fish called *chilichima* (popularly known as *vāliyā*), the *varmī*, the *maśakari*, the *rohita* (*cyprinus rohita*), and the *rājīva*. In the opinion of Manu (V, 16), the *pāṭhina* (*silurus boalis*) and the *rohita* may be eaten, if used for offering to the gods or to the *manes*, while the *rājīva* (those marked with lines), the *siṁhatuṇḍa* (lion-beaked) and the *saśalka* (those having fins and scales) may be eaten on all occasions. The law-books prohibit the fishes that are misshappen. Āpastamba forbids also those which are snake-headed and those which live on flesh only.'

Even judged by the above-noted injunctions, Eels, Skates, Rays, and Globe-fishes should not be eaten as they are misshappen while Shark eats flesh only and, therefore, its eating is forbidden.

Asoka's Fishery Legislation

Having declared certain undesirable species as inviolable, Asoka then legislates for the conservation of the desirable species as a whole.

Hultzsch's [1] free translation of the relevant passage may be reiterated here for the sake of convenience:

'Fish are inviolable and must not be sold on the three *Chāturmāsīs*, (and) on the Tishyā full moon, during three days, viz. the fourteenth, fifteenth, and the first *tithi* and invariably on every fast day.'

'And during these same days no other classes of animals which are in the elephant park and the preserves of the fishermen must be killed.'

Buhler [2] rendered this passage as:

'At the (*full moon of each*) of the three seasons and at the full moon of *Taisha* or *Pausha* fish shall neither be killed nor sold during three days, viz. the 14th, 15th, and the first of the following fortnight, nor constantly on each fast day.'

According to Buhler:

'*Chāturmāsī* is the full moon of each term of season of four months (summer, rains and winter) and it is not possible to decide with certainty which full moons are meant. They may be those of Phālguna, Āshāḍha and Kārttika or those of Chaitra, Śrāvaṇa, and Mārgaśīrsha.'

'The fourth full moon, which our passage mentions, is that of Taisha or Pausha (Dec.-Jan.).'

According to Barua (p. 367):

'Aśoka's expression *tīsu chātuṁmāsīsu* cannot but mean the three full moon days that occurred in Āshāḍha, Kārttika, and Phālguṇa, at the end of the three four-monthly seasons and were observed in the Middle Country as holidays.'

I have given a great deal of thought to the above translations and commentaries and have tried to equate them against our present-day knowledge of the fisheries of our rivers; but I cannot make any sense unless *tīsu chātuṁmāsīsu* is translated as the third *Chāturmāsī* and not as three *Chāturmāsīs* as is evident from the plural number of both the words. It is not a scribe's mistake as in all the six Pillars the same words are repeated. In connection with Asoka's Inscriptions, Barua (Pt. II, p. 97, 1941) observed that

'Provided that the rhythm is maintained, the cadences are right, the sounds are sweet and appropriate in rhyming, and the caesuras come spontaneously, it is immaterial whether certain rules of number and gender are obeyed or infringed.'

I believe *tīsu chātuṁmāsīsu* is also a case of the infringement of rules of number and in view of what I am going to state below, it should be taken to mean the third *Chāturmāsī*. Some support is lent to this view by Barua himself (p. 371), for he observes that

'Regarding these prohibitions, it is curious to note that they follow the lines laid down by Kauṭilya (XIII, 5): "the king (in a conquered territory) should prohibit the slaughter of animals for half a month during the periods of *Chāturmāsya* (from July to September), for four nights on the full moon days, and for a night to mark the date of his birth, or celebrate the anniversary of his conquest. He should also prohibit the slaughter of females and young ones as well as castration".'

In explaining *chātuṁmāsiye chātuṁmāsi-pakhāye*, Barua (p. 373) observes that

'In the third context the expression, *tīsu chātuṁmāsīsu* (a 7th case, plural) (is substituted) by *chātuṁmāsīye* (a first, second, or fourth case singular). Even as a fourth

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[1] Hultzsch, E.—'Inscriptions of Asoka' in *Corpus Inscriptionum Indicarum* p. 128 (1925).

[2] Buhler, G.—*Epigraphia Indica*, II, pp. 258-9 (1894).

case singular, *chātummāsīye* means the continuance of the full moon of a four-monthly season, may be a particular season, say, the rainy. As a first or second case singular, *chāturmāsiye* may be equated with the Sk. *chāturmāsyaḥ* or *chāturmāsyam*, "during the period of the *chāturmāsya* (July–Sept.)".'

According to Barua (p. 371), 'The fish and other creatures got relief for not less than seventy-two days in the year, calculated at the rate of 3 days in every lunar half-month, *viz.* the first, the eighth, and the full or new moon. The three *Chāturmāsī* and *Taisha* full moon days are all included in the list of full moon days throughout the year.'

Dr. B. C. Law has very kindly informed me that 'Asoka followed the popular Brahmanical practice which held the four days of the changes of the moon as sacred Sabbath days. The Jains and Buddhists also followed this practice. In fixing *uposatha* days they adopted Brahmanical usages'.

If my contention is correct that the catching of fish was prohibited during the third *Chāturmāsī* on the 14th and 15th day of the moon and the first day after the full moon, then the close periods are based on a remarkable insight into the breeding habits of the common food fishes of the fresh waters of India. The most important groups of fishes are the Carps, such as Catla (*Catla catla*), Rohita (*Labeo rohita*), Mrigal (*Cirrhima mrigala*), Calbaus (*Labeo calbasu*), etc.; Cat-fishes, such as Boal (*Wallago attu*), Silond (*Silonia silondia*); Pangas (*Pangasius pangasius*), Vacha (*Eutropiichthys vacha*), etc., and the Hilsa (*Hilsa ilisha*). All these fishes breed in the rainy season when the rivers are flooded. Usually the heavy breeding occurs during July and August but, depending on the early or late rains, the breeding may start in June or may last up to September also. One further thing which has come to light in recent years, though it has not yet been firmly established, is that the breeding is influenced by the phases of the moon or in other words there is a lunar periodicity in the reproduction of the principal freshwater fishes of India. The principal fishery of Hilsa, for instance, is round about the full moon and the new moon periods and the breeding of Carps, so far recorded or observed, has also been round about the same periods and the eighth day.

Let us consider the information regarding the breeding of Carps first, bearing in mind that heavy rainfall in Chittagong starts in April and not in June-July as in the Gangetic Plain.

Lunar Periodicity in the Spawning of Indian Carps

Majumdar [1], while describing the spawning grounds of Carps in the District of Chittagong, observed that 'the spawning day generally falls within three days prior to or after the full moon or the new moon day during the months of April to July.' My own observations for the Chittagong area are as follows:—

1945—

12th April	Seven days after full moon and the same period before new moon.
10th May	One day before new moon.
26th May	One day before full moon.
10th June	New moon day.

[1] Majumdar, C. H.—Spawning Grounds and Hatcheries in the District of Chittagong, Bengal. *Sci. and Cult.*, pp. 735–739 (1940).

1946—

1st April .	Eight days after new moon.
30th April .	One day before new moon.
17th May .	One day after full moon.
10th to 12th June	Full moon: 13th June.

1947—

23rd April .	Two days after new moon.
23rd May .	Three days after new moon.

Dr. Nazir Ahmad [1] has already referred to these dates of spawning.

The data for the Gangetic Plain are few but it was noted that in 1946 the fish bred on the 14th July, full moon day, and on the 30th September, 5 days after new moon.

In considering the above data, two factors of error may be borne in mind. Firstly, the data were supplied to me by the District Fishery Officers who had no idea of the object for which the information was collected. As they in turn depended on fishermen for information there was probably a time-lag between the day of actual breeding and the day information was received and transmitted to the Head Office at Calcutta. The second factor is the weather conditions prevailing during the breeding period. Such weather conditions as thunderstorms, lack of floods, heavy rains, cloudy days, etc., etc., are known to influence spawning.

It is not to be presumed from the above that Carps bred only on the days specified above. Probably they breed throughout the rainy season but spawning is intensified during the full moon and new moon periods and on the Ashṭamī days.

Lunar Periodicity in the Spawning of Hilsa

In the case of Hilsa, Majumdar [2] stated that in the Sundarbans the fishing is done during the neaptide periods. Prashad, Hora, and Nair [3] reported that on the Balasore Coast Hilsa fishing is done from the 11th day of the moon till to the 3rd day after the full moon and then from the 11th day after the full moon to a day or two after the new moon. A similar periodicity in the fishing for Hilsa has been observed in the Narbada River by Dr. C. V. Kulkarni of the Bombay Fisheries Department. He obtained fertilized eggs in plankton collecting on August 22, 1949, the fourteenth day of the moon.

The above data, inadequate as they undoubtedly are, indicate very clearly that (i) there is a lunar rhythm or periodicity in the breeding of the principal food fishes of Indian fresh waters and (ii) whereas new-moon and full-moon periods are most favourable for the spawning of the Carps and Hilsa, the eighth day after the full moon or new moon is also significant in the spawning of the Carps. If these inadequate data are now read with the injunctions contained in the Pillar Edict V, one must wonder at the

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[1] Ahmad, Nazir—Methods of collection and hatching of Carp ova in Chittagong with some suggestions for their improvement. *Journ. Bombay Nat. Hist. Soc.*, XLVII, p. 595 (1948).

[2] Majumdar, C. H.—Foreshore Fishing in the Eastern Part of the Bay of Bengal. *Sci. and Cult.*, V, pp. 219–221 (1938).

[3] Prashad, B., Hora, S. L., and Nair, K. K.—Observations on the Seaward Migration of *Hilsa ilisha* (Hamilton). *Rec. Ind. Mus.*, XLI, pp. 409–418 (1940).

accuracy and deep insight our ancestors had regarding the fisheries in India, particularly of the Gangetic Plain.

SCIENTIFIC ANALYSIS OF ASOKA'S LAWS

Having established that Asoka's injunctions regarding the catching of fish are based on true scientific principles, let us now examine these laws in greater details. Asoka's law was that—

1. No fish should be caught on the 14th and 15th day of the moon and the first day after the full moon during the period of the 3rd Chāturmāsī[1] (*Śrāvaṇa*, July-August; *Bhādra*, August-September; *Āśvina*, September-October, and *Kārtika*, October-November) = 12 days.
2. No fish should be caught on the 14th and 15th day of the moon and the 1st day after the full moon of the month of *Pausha* (December-January) = 3 days.
3. No fish should be caught on the fast days—*Amāvasyā* or the day before new moon and the *Ashṭamī* or the eighth day during every fortnightly period of the moon = 12+24 = 36 days.
4. No tank fish (animals in the preserves of fishermen) should be taken during the above-noted days.

The total number of fish-prohibition days enjoined by Asoka would thus appear to be 51 unless there were other fast days besides the ones I have referred to above. Barua has counted 72 at the rate of 3 days in every half lunar month, the first, the eighth, and the full or new moon day. This is a point on which further co-ordinated research is necessary by Orientalists and Fishery Biologists. According to Dr. B. C. Law, Asoka prohibited the killing and sale of fish for 24+32 = 56 days.

FULL MOON PERIODS IN RELATION TO FISHERY CONSERVATION

The first injunction is not to catch fish during the 14th, 15th and full moon days falling during the period commencing from the middle of July to the middle of November. The peak breeding period of India's principal food fishes is July, August, and September but Asoka's prohibition period extends up to the middle of November. This extended period is also scientifically logical, because after breeding in shallow areas or up-river the spent fish fall back to their normal habitats in deeper waters or in the case of Hilsa to the estuaries and the sea. The young also move down to safer habitats after the rains are over and the flooded areas begin to contract. The young and the weakened spent fishes need protection and it is indeed remarkable that even this was thought of in the remote ancient age. It is perhaps significant to note here that in Bengal Hindus generally do not take Hilsa after the Durga Pooja (sometime in October) to the Saraswati Pooja (towards the end of January).

There is another great virtue in this law in so far as prohibition is restricted only to certain specified days and not to the entire season. The fecundity of Carps and Hilsa is well known, for a pair of spawners, under favourable conditions, can produce millions of young. So nearly 6 days restriction during each spawning month is ample for the conservation of

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[1] Though at present the Hindu New Year begins in *Vaiśākha* about the middle of April, in ancient times the year commenced in *Agrahāyaṇa* about the middle of November. It is on this basis that the third Chāturmāsī of the year will comprise the months of *Śrāvaṇa, Bhādra, Āśvina,* and *Kārtika.*

the fisheries, and does not interfere with the trade or the occupation of fishermen to any very great extent.

The significance of the second law whereby catching of fish is prohibited on the 14th and 15th day of the moon and the 1st day after the full moon besides the fast days of the month of *Pausha* (December-January) is not quite clear to me. This may be meant to protect the fishes during the height of the cold season, when the fish, particularly in the northern parts of the Gangetic Plain, are benumbed and lose much of their vitality and can sometimes be caught with hands. However, this point needs further investigation.

Fast days in relation to Fishery Conservation

As regards prohibition on all fast days, there are many virtues in this injunction. Firstly, the trade will not be affected to any very great extent and fishermen themselves will be able to observe fasts. Secondly, besides the principal food fishes there are other varieties which do not breed during the rainy season but at other times of the year. Thirdly, by spreading prohibition in driblets over the whole of the year greater respect for law is assured and no hardship could be felt by the public.

It may be worthwhile to record here that the principal food-fishes of the Gangetic estuaries, such as Mullets, Prawns, Bhetki, etc., breed in March and April and the salt-water *Bheries* take in water containing the eggs and young-ones of these species during the spring tides of the new moon and full moon periods for stocking purposes. For further details reference may be made to the first Fishery Development Bulletin of the Government of Bengal by Hora and Nair published in 1943.

Prohibition on Tank Fishing in relation to Fishery Conservation

The fourth law by which tank fishing is prohibited is perhaps the most ingenious of all, for it has nothing to do with the spawning of fishes. The Indian Carps and Hilsa do not breed in tanks and in spite of many efforts by different Governments in the recent past they have not been induced to breed in confined impounded areas. As the tank fishes are the same as are found in rivers, it would have been difficult to control their sale and at the same time prohibit the catching of fish in the rivers. It was indeed very wise, therefore, to prohibit the catching of all fish for the control of marketing.

Evolution of Fishery Laws in Ancient India

How the ancient Hindus came to frame such complicated laws in such a pleasant manner and how they came to the views embodied in the laws will perhaps remain obscure for a long time to come till science and oriental knowledge are brought together in a very close and intimate collaboration. There is some indication that Asoka's Pillar Edict V records an advancement of knowledge over what Kauṭilya had recommended in his *Arthaśāstra* about 25 to 50 years earlier. He had recommended that the king should prohibit the slaughter of animals for half a month during the periods of *Çhāturmāsya* (from July to September), for four nights on the full moon days, and for a night to mark the date of his birth, or celebrate the anniversary of his conquest. It will be obvious from what has been stated regarding the scientific basis of Asoka's laws that they are more perfect, humane, just, and easy to comply with.

Present-day Fishery Legislation in India

The conservation method usually adopted are:—

1. Restriction of mesh of nets and other approved method of capture.
2. Prohibition of wholesale destruction by poisoning or dynamiting, etc.
3. Prohibition of capture of brood fish and young ones.
4. Closure of sections of rivers to serve as sanctuaries throughout the year.

I am more familiar with the fisheries of Bengal than with that of any other part of India, so I shall give some of the fishery legislation in this part of the Gangetic Plain.

In reserved and protected forests rules made under the appropriate sections of the Forest Act prohibit poisoning of any river or other water, killing fish by explosives, damming or bailing water and use of any fixed engine, such as net, cage, trap or other contrivance to catch fish.

For other areas, the Indian Fisheries Act IV of 1897 forbids and penalizes the use of explosives or poison to kill fish in any waters including the sea within one marine league of the coast. It further gives power to government to make rules for regulating the construction and use, in waters which are not private waters, of fixed engines and weirs, and the dimensions of nets together with modes of using them. Fishing in any specified waters may also be prohibited for a period not exceeding two years.

The Private Fisheries Protection Act (Bengal Act II of 1899) penalizes catching or destruction of fish, without permission of the person who owns the right of fishing, by 'fixed engine' or 'any matter'. This act, it seems, is designed more for prevention of theft of fish from private fisheries than for the conservation of fish therein.

It will be seen that the existing legal provisions for the protection of fish and conservation of fisheries are defective and for want of any machinery for enforcing them they are almost a dead letter. There is no provision against selling or buying or offering for sale and this practically nullifies all protective measures. To remedy this defect the Imperial (now Indian) Council of Agricultural Research discussed the subject of 'Conservation of Inland Fisheries by Legislation' in 1944 and two or three subsequent years and even collected views of all the Provincial and State Governments but no finality was reached and the matter now rests in the archives of the Indian Council of Agricultural Research.

Conclusions and Suggestions

A comparison between the present-day laws and those promulgated by Asoka will show the following important differences:—

1. Asoka's laws were very simple, applicable throughout his kingdom, and the prohibition periods were evenly spread over the whole of the year thus entailing no hardship either on the consumers or on fishermen. The present-day laws are complicated, piecemeal in application and through total prohibition during certain seasons inflict many hardships both on the consumers and fishermen.
2. Asoka prohibited the sale of fish, even from tanks, on certain days and, therefore, the enforcement of his laws was very easy. In the existing laws, for securing conviction for a

wrong deed, unless caught red-handed with reliable witnesses round about, much time has to be wasted as the procedure is very cumbersome.

3. Asoka's laws were based on the proper understanding of the migratory and spawning movements of the principal food-fishes of India, whereas the present laws are based on presumptions, and scientific data are now being collected to improve upon them.

On a very careful consideration of the whole matter, I feel that the Indian Union cannot, under the present circumstances, think of any better legislative measures for the conservation of its inland fisheries than to enact the laws promulgated by the good king Asoka in 246 B.C. We would thereby build up the economy of India on ancient skill, which is our heritage, but would not overlook to enlarge this knowledge by a scientific understanding.

With the Author's Compliments

Excerpt from the

BULLETIN

OF THE

BOTANICAL SOCIETY OF BENGAL

(Vol. 4, No. 1, April, 1950)

SOME IMPRESSIONS OF THE UNITED NATIONS SCIENTIFIC CONFERENCE ON THE CONSERVATION AND UTILIZATION OF RESOURCES.

BY

SUNDER LAL HORA

(Zoological Survey of India, Calcutta.)

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Some Impressions of the United Nations Scientific Conference on the Conservation and Utilization of Resources

SUNDER LAL HORA

(Zoological Survey of India, Calcutta.)

It is not my intention to speak today on any aspect of fisheries development in India, for my views are fairly well known already. With regard to fish supplies in Western Bengal, attention is invited to my very recent article entitled "Fisheries Resources of Western Bengal and their Utilization" published in *Science and Culture, 15,* 176-180, November, 1949. I wish, however, to say that my recent visit to the U.S.A. has strengthened my belief that for any immediate increase in fish supplies *"it is necessary to carry out a large number of smaller, less ambitious, but economically sound projects which will in the aggregate increase production considerably".* I wish also to reiterate that a lasting and nation-wide development of fisheries must be a slow and gradual process of the evolutionary type and any hurried spectacular measures are bound to fail. The pace of development will largely depend on the training and experience of the personnel actually engaged in the fishing industry or its betterment from a purely administrative point of view. This naturally would lead to a consideration of the inter-relationship between the quantity and variety of food to be produced and the producers' socio-economic condition and the tastes and likings of the consumers. We have hitherto ignored these fundamental considerations and have worked our programmes according to western ideas and to our own likes and dislikes, without regard to the peasant economy in India and the ancient genius of our people. It is no wonder that our best paper programmes have not yielded any statisfactory results. The problems of food production are peoples' problems and can, therefore, be best tackled among the people in the field and not round a secretariat table.

Increasing population is a bogey raised to hide our inefficiency in conserving and properly utilizing our natural resources. It was the opinion of some at the United Nations Scientific Conference that the world as a whole is capable of supporting almost double or three times the existing population if the nations pooled their resources and worked them out properly for the good of the people as a whole. The increasing population is, therefore, a challenge to humanity to put its house in order or to perish.

It was a great surprise for me to learn that not very long ago, about 30 to 40 years, the agriculturists in the U.S.A. were contemptuously called "Hay-Seeds" and the fishermen by a still worse name. The present position is that an agriculturist is envied by every one and the income and standard of living of an average Pacific Fisherman is superior to the university teachers. The fisherman calls for research himself and is prepared to pay for it, for he knows that increased food production is not only good for the people but it brings him more money for a still better standard of living. It is my considered opinion, based on discussions with eminent fisheries development authorities in the U.S.A., that the first and foremost requisite for increased fish supplies in India is to deal with the backward fishing community most sympathetically and raise their socio-economic standard. If we had paid attention to this aspect right from 1942, when the Fisheries Directorate was re-established in Bengal we would not have complained of shortage of fish supplies today but may have been thinking of export markets.

There is a Punjabi saying which when freely translated would read as: Listen my friends, among the occupations most suitable for man, agriculture is the most superior, next comes trade and commerce (business) and the worst of all is service of any kind. This shows the great value that was attached to the agricultural labour in the past. In the present circumstances, it seems to me most appropriate that the nation should assign a very high social status to the producers of food. This will check the exodus from the land to urban areas and may even lead the educated people to go back to their lands. Some socio-economic research is called for to achieve these results but once the dignity of labour is recognised the battle for food will be won in no

In discussing measures for fishery development in an informal meeting, the representatives of the Fisheries Section of the United Nations Scientific Conference realized that the foremost need in any programme of increased production was Consumer Research. How true this is will be clear from the Report of Herring Meeting held in the Hague, Netherlands, from 29 August to 2 September 1949 under the auspices of the F.A.O. It was felt at this meeting that with the application of recently discovered innovations, such as the echo-sounding, midwater trawl, radio-telephone, aeroplane tracing of herring, pumps for discharging fish from gear and from vessels, the production was bound to increase but the marketing of increased production was the greatest obstacle at present. It was suggested in this connection that *"the hitherto unexplored possibilities of opening up new markets in*

Asia and Africa, by the processing of herring in a form acceptable to the people of these continents, is a challenge to the industry. Attempts to introduce traditional European herring cures into Asia and Africa are not likely to have much success, but a study of the tastes and processing methods for fish in Asiatic and African countries may provide a clue for a process that could be applied to herring and make it saleable in those countries."

Consumer Research in food industries is very important, for sometimes consumer tastes change irrespective of price. This imposes on the industry the need to study the reasons for these changes in consumer habits, and the need to devise new and more acceptable forms in which to market their products. I am personally aware with regard to at least one small catfish of Bengal, *Nuna Tengra* (*Aoria gulio*), where the consumer habits changed during the last war. This fish was considered of inferior quality in the Calcutta markets by the middle-class people but during the War, when Carp and other larger varieties became expensive owing to the Military demand, they took to eating this fish and found that it makes excellent curry on account of plenty of oil in its body tissues. Now this species fetches almost the same price as larger varieties of Carps and Catfishes and a big market for this species has developed. If consumer tastes could be developed for other smaller varieties of fish, which are at present uneconomical to catch and market, there will be abundant supplies and the prices will come down greatly. I have seen in the Sundarbans fishermen throw-away large quantities of smaller fishes, for lack of any market for them. It seems necessary, therefore, that, for the increased marketable production of fish, consumer research is of paramount importance but, unfortunately, this has not been attempted in India as yet.

Another reason why food production is not making headway in India became clear to me when I was attending the Pacific Tuna Fisheries Conference at San Pedro on October 10, 1949. The programmes submitted by different scientists were fully criticised in a give and take spirit but no bitterness among persons resulted therefrom. In India on the other hand proper discussion of any programme is out of the question as any adverse remarks are invariably imputed to some personal grudge or motive. It is often painful to hear that a certain well informed person did not dare to express his views in a meeting though, according to his honest belief, a wrong decision was being taken. Unless the present-day fascism from such meetings is excluded, one is apt to regard Annandale's dictum that the wisdom of a Committee is less than that of the least intelligent member of the Committee as perfectly justified. In the same meeting, it was freely men-

tioned that any improvement in catching methods should be economical as compared with the existing practices, and for this reason present-day catches and their costs should be borne in mind constantly. This is a very healthy outlook and should be borne in all development plans in India. Having paid considerable attention to the measures adopted in the West for food production, I feel that it will be ruinous for us to imitate those practices because they are not applicable to the peasant economy in India, to the social structure of the Society and to the traditional knowledge we have acquired through centuries of experience. Has any one investigated against the Socio-Economic Background of the peasantry in India whether the methods and technology perfected in advanced countries are applicable to the so-called under-developed countries? I am afraid, not. Our peasants may be illiterate but are by no means ignorant; they may be conservative but not without reason; they may be superstitious but not without experience of natural phenomenon. I have personally found the fishermen full of knowledge but unfortunately the society gives them no chance. We do not blame any individuals, the whole structure of the Society requires reconstruction. Here again is a challenge to the men of social sciences. Summarising the views of the Fish Section of the U. N. Scientific Conference on the cultivation of fresh and brackish water fish in Warm climates, Mr. Michael Graham of the U.K. stated:

> "Here there is room for very great expansion. And, what is more, it is almost on the door-step of many millions of people in tropical countries who are at present protein-starved. In some areas, such as the rice country, they can hardly hope ever to obtain flesh because the land is all taken up for rice. The greatest skill in this art of pond culture lies traditionally in China, secondly in the continent of India, and the first aim is to spread their methods round the world, with suitable local modifications. We should build on what we have. But new possibilities, such as the greater use of the various species of the fish called *Tilapia,* were also mentioned. It was the manifest opinion of the meeting on August 24 that the *possibilities for human betterment,* by the increased tropical pond-culture, could hardly be exaggerated. At the same time we realised that success would depend on human cunning and tact in dealing with all the varieties of ponds and lakes and lagoons and water courses. Our skill must be no less subtle, though more scientific, than the traditional fine discrimination of the Chinese masters of the art.

We should build on ancient skill but spread by scientific understanding".

No other method of approach in the under-developed countries can be effective or ever lasting.

The United Nations Scientific Conference was debarred by the terms of its reference to pass any resolutions and its main objective was to facilitate the exchange of views among scientists of various countries. In the concluding phases of the Conference, it was more and more realized that in the development of natural resources it was necessary to pay more attention to man, for he was the greatest natural resource of the world. This view found expression in Resolution No. 1 of the International Technical Conference on the Protection of Nature which was held from the 22nd to the 29th August 1949 at Lake Success under the auspices of UNESCO. The resolution is worth quoting in its entirety as it applies equally well to the subject of our Symposium today—**Food and People.**

International Technical Conference on the Protection of Nature.

Resolution No. 1.

Whereas: The United Nations and its Specialized Agencies are studying programmes of technical assistance for under-developed countries, which programmes to be effective require the application of human ecological principles, ecology being understood in its widest sense to include all human relationships—individuals and groups—with the problems discussed, it is essential that existing information should be collected and new studies that are urgently needed should be initiated, and

Whereas: It is recognized that one of the first and greatest responsibilities of the United Nations and its Specialized Agencies concerned with the use of resources, and of the International Union for the Protection of Nature, is to increase knowledge of human ecology, and to assure its application on a scientific basis, and

Whereas: This Conference recognizes the necessity of close and continuous integration of all programme and methods for the study of human ecology,

Therefore this Conference resolves: That the International Union for the Protection of Nature recommend to the above-mentioned bodies the promotion of studies of suitable areas as a step towards the development of an adequate methodology for investigation of human logy, and

Further resolves: That such studies be conducted along the following lines:

1. One or more ecological areas shall be selected for thoroughgoing study, including the human factors in the situation.
2. These ecological areas should be selected so that they shall be:
   (a) Practicable units for a simple, integrated programme, small enough to permit complete studies, and large enough to provide significant results,
   (b) Distributed through representative biogeographic areas.
3. Each area shall be treated as a total dynamic ecological situation, including all possible factors such as soil, water, food, climate, plants, animals and the people concerned, with special emphasis on their interrelationships.
4. These studies shall be made by teams of scientists trained in ecological methods. This multi-discipline and inter- discipline approach is to include the methods of the physical and biological sciences together with those of human ecology, medicine, sociology, anthropology, genetics, economics and psychology.
5. These studies should be concerned not only with the amassing of data and the interpretation of the ecological situations under study, but also with the development and recording of the methodology used, including the logic, concepts, methods, procedures, techniques, and "inventions" physical, biological, and social.
6. The findings of these studies, both in fact and in method, will assist in the orientation and integration of all the different disciplines applied in the studies.
7. The results of these studies should be published and made available to specialist: Also, popular versions of the significant results should be made available in several languages to the general public.

Those of us, who have worked in the field and among the people, have realized that for any programme of food production a thoroughly reliable and efficient extension service is far more important than multitudes of Research Stations and Organizations. It is not only that Food is essential for People but properly informed people are also equally essential for Food Production. Let us, therefore, bring the problems of Food and People together and consider them simultaneously.

[Reprinted from the *Journal of Scientific & Industrial Research*, 1950, V. 9A, No. 5, pp. 143-145]

Food & People — Development of Fisheries*

A LASTING and nationwide development of fisheries must be a slow and gradual process of the evolutionary type, and any hurried spectacular measures are bound to fail. The pace of development will largely depend on the training and experience of the personnel actually engaged in the fishing industry or its betterment from a purely administrative point of view. This naturally would lead to a consideration of the interrelationship between the quantity of variety of food to be produced, the producers' socio-economic conditions and the tastes and likings of the consumers. We have hitherto ignored these fundamental considerations and have worked our programmes according to western ideas and to our own likes and dislikes without regard to the peasant economy in India and the ancient genius of our people. The problems of food production are peoples' problems, and can, therefore, be best tackled among the people in the field.

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Consumer Research Essential

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* From a contribution by Dr. Sunder Lal Hora to the symposium on "Food & People" organized by the Botanical Society of India. The paper in its original form will be published in the *Journal of the Botanical Society*.

discharging fish from gear and from vessels, the production was bound to increase, but the marketing of increased production was the greatest obstacle at present. It was suggested in this connection that "the hitherto unexplored possibilities of opening up new markets in Asia and Africa, by the processing of herring in a form acceptable to the people of these continents, is a challenge to the industry. Attempts to introduce traditional European herring cures into Asia and Africa are not likely to have much success, but a study of the tastes and processing methods for fish in Asian and African countries may provide a clue for a process that could be applied to herring and make it salable in those countries."

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Build on Ancient Skill

Another reason why food production is not making headway in India became clear to me when I was attending the Pacific Tuna Fisheries Conference at San Pedro on 10th October 1949. It was freely mentioned that any improvement in catching methods should be economical as compared with the existing practices, and for this reason present-day catches and their costs should be borne in mind constantly. This is a very healthy outlook and should be borne in all development plans in India. Having paid considerable attention to the measures adopted in the west for food production, I feel that it will be ruinous for us to imitate those practices because they are not applicable to the peasant economy in India, to the social structure of the society, and to the traditional knowledge we have acquired through centuries of experience. Has any one investigated against the socio-economic background of the peasantry in India whether the method and technology perfected in advanced countries are applicable to the so-called under-developed countries? I am afraid, not. Our peasants may be illiterate but are by no means ignorant; they may be conservative but not without reason; they may be superstitious but not without experience of natural phenomena. I have personally found the fishermen full of knowledge but unfortunately the society gives them no chance. We do not blame any individuals, the whole structure of the society requires reconstruction. Here again is a challenge to the men of social sciences. Summarizing the views of the Fish Section of the U.N. Scientific Conference on the cultivation of fresh and brackish water fish in warm climates, Mr. Michael Graham of the U.K. stated:

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Man, the Greatest National Resource

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"*Further resolves* that such studies be conducted along the following lines: (1) One or more ecological areas shall be selected for thorough-going study, including the human factors in the situation; (2) these ecological areas should be selected so that they shall be: (a) practicable units for a simple, integrated programme, small enough to permit complete studies, and large enough to provide significant results, and (b) distributed through representative bio-geographic areas; (3) each area shall be treated as a total dynamic ecological situation, including all possible factors such as soil, water, food, climate, plants, animals, and the people concerned, with special emphasis on their interrelationships; (4) these studies shall be made by teams of scientists trained in ecological methods. This multi-discipline and inter-discipline approach is to include the methods of the physical and biological sciences together with those of human ecology, medicine, sociology, anthropology, genetics, economics and psychology; (5) these studies should be concerned not only with the amassing of data and the interpretation of the ecological situations under study, but also with the development and recording of the methodology used, including the logic, concepts, methods, procedures, techniques and "inventions" — physical, biological, and social; (6) the findings of these studies, both in fact and in method, will assist in the orientation and integration of all the different disciplines applied in the studies; (7) the results of these studies should be published and made available to specialists. Also, popular versions of the significant results should be made available in several languages to the general public."

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SUNDER LAL HORA

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RECORDS

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INDIAN MUSEUM

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A note on the Systematic position of the two Gastromyzonid genera *Protomyzon* Hora and *Paraprotomyzon* Pellegrin and Fang (Fishes: Cyprinoidea).

S. L. Hora & K. C. Jayaram.

CALCUTTA:

A NOTE ON THE SYSTEMATIC POSITION OF THE TWO GASTROMYZONID GENERA *PROTOMYZON* HORA AND *PARAPROTOMYZON* PELLEGRIN AND FANG (FISHES: CYPRINOIDFA).

By SUNDER LAL HORA, *D.Sc.*, *F.R.S.E.*, *C.M.Z.S.*, *F.R.A.S.B.*, *F.N.I.*, *Director*, and K. C. JAYARAM, *B.Sc.*, *Assistant*, *Zoological Survey of India, Indian Museum, Calcutta.*

In his monograph on the Homalopteridae, Hora[1] proposed a new genus *Protomyzon* to accommodate Vaillant's[2] *Homaloptera whiteheadi* from Mount Kina Balu, Borneo. The genus was referred to the subfamily Gastromyzoninae and was characterized by the following combination of characters :—

i. Gill-openings of moderate size, extending to ventral surface for short distance.

ii. Absence of any rostral groove and rostral fold.

iii. Two pairs of rostral barbels fully exposed on ventral surface.

iv. Snout broad and rounded and mouth slightly arched.

v. Eleven rays in the pelvic fin.

Under the description of the genus, it was noted that—

> " In general build and facies the new genus resembles certain torrent-inhabiting species of *Nemachilus*, but is distinguished from them by the possession of a large number of rays (22) in the pectoral fin. It seems to me probable that *Protomyzon* may have evolved from *Nemachilus*-like ancestors under the influence of swift currents."

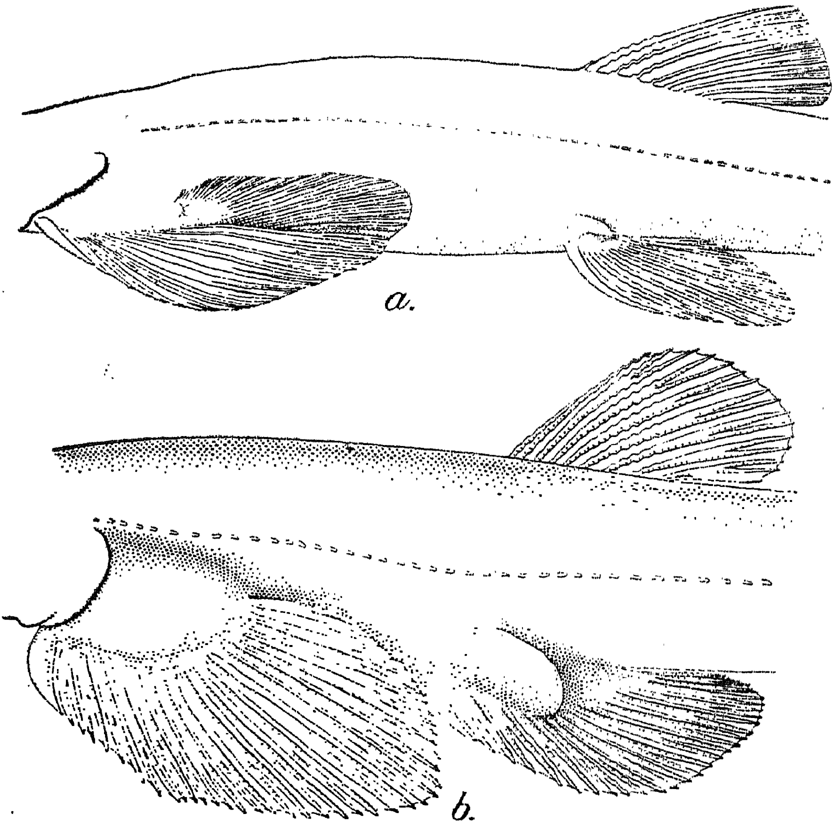
It is still a monotypic genus and the only material examined by Hora comprised of 2 large and 5 young specimens in the Paris Museum and these he found to be " very soft " and " not in a good state of preservation ". The same material was re-examined by Pellegrin and Fang[3] in 1935, when they described another new genus *Paraprotomyzon* from Kwai-show, Eastern Szechuan. They corrected Hora's description with regard to the extent of the gill-openings and observed (p. 102) :

> " Practically, *Protomyzon whiteheadi* is distinctly possessing the gill-opening. although elongate, but pertaining on the dorsal side of head. His description of *Protomyzon* as having the gill-opening extending a short distance to the ventral surface is merely based upon the injured side of one specimen of the two, now preserved in the Paris Museum."

Pellegrin and Fang were correct in their account of the gill-openings of *Protomyzon*, but it must be noted that gill-openings in both *Protomyzon* and *Paraprotomyzon* are not as restricted as in *Gastromyzon*. Though they are restricted to the dorsal surface, they almost extend to the base of the pectoral fin dorsally. If Hora had evaluated this character correctly for his *Protomyzon*, he would have placed this genus in group

[1] Hora, S. L., *Mem. Ind. Mus.* XII, p. 306 (1932)
[2] Vaillant, M. L., *Nouv. Arch. Mus.* V, p. 92 (1893).
[3] Pellegrin, J. & Fang, P. W., *Sinensia* VI, p. 99

II of his key on page 304 along with such genera as *Pseudogastromyzon*, *Sewellia*, *Beaufortia*, *Neogastroymzon* and *Gastromyzon*. This group is aptly described by Pellegrin and Fang as the Gastromyzonian-group, as against the Crossostomanian-group of the genera *Annamia*, *Crossostoma*, *Vanmanenennia*, *Formosania*, *Parhomaloptera*, etc. *Paraprotomyzon* also pertains to the Gastromyzonian-group, but it has been distinguished from *Protomyzon* by the extent of the pectoral fins (extending beyond bases of



Text-Fig. 1.—Lateral view of body, with parts of head and tail regions in *Protomyzon* Hora and *Paraprotomyzon* Pellegrin & Fang × $2\frac{2}{3}$.

a. *Protomyzon whiteheadi* (Vaillant).

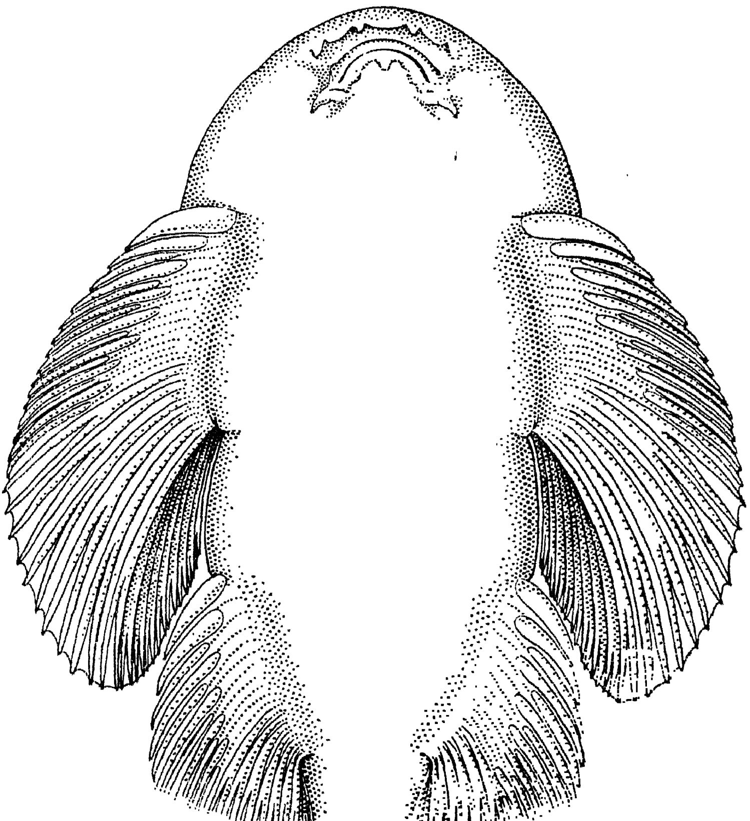
b. *Paraprotomyzon multifasciatus* Pellegrin & Fang.

Notice the similarity in the extent of the gill-openings in both and the dissimilarity in the extent of the pectoral fin in relation to the position of the pelvic fins. Special attention is also invited to the nature of the appendage at the base of the pelvic fins in the two genera.

pelvics *versus* remote from bases of pelvics), number of rays in the pelvic fins (1/14 *versus* 1/7) and lepidosis (ventral surface naked before pelvics *vs* naked thorax region and a small portion behind it). Relying

mainly on the number of fin rays in the pelvic fin, and comparing in this respect their *Paraprotomyzon multifasciatus* with the known species of *Pseudogastromyzon*, they observed:

> "It may be that *Paraprotomyzon* is a genus intermediate between *Protomyzon* and *Pseudogastromyzon*, or it may be a genus in parallel development with the latter and having *Protomyzon* as their common ancestor. For the first conception, it will be better to consider *Paraprotomyzon multifasciatus* as a more specialized species in the genus *Paraprotomyzon*."



.—Ventral surface of head and body of *Paraprotomyzon multifasciatus* Pellegrin & Fang × 3⅓.

In a recently published synopsis of all the known Chinese Homalopteridae, Chen and Liang[1] have included *Paraprotomyzon* in their list next to *Pseudogastromyzon* without any comments but distinguished the two genera by the number of rays in the pelvic fins (8-11 in *Pseudogastromyzon versus* 15 in *Paraprotomyzon*).

During his recent visit to the U.S.A., Hora found a big collection of fishes from Mount Kina Balu, Borneo, in the Museum of Comparative Zoology at Harvard College, Cambridge, Mass. This collection was made

[1] Chen, J. T. F. & Liang, Y., *Quart. Journ. Taiwan Mus.* II, p. 161 (1949).

by Mr. J. A. Griswold, now of the Zoological Society of Philadelphia Pa. Among these, there is a lot of about 100 specimens labelled as Homalopteridae (CMZ. Nos. 34794, 34800, 34801, 34806, 34833, 37038). On a casual examination in the Museum, they were provisionally referred by Hora to *Protomyzon whiteheadi* (Vaillant). Forty-five specimens of this lot have now become available in Calcutta for detailed study through the kindness of Dr. William C. Schroeder. Several other species of fish and some tadpoles have been found associated with *Protomyzon*. Dr. P. L. Bertin of the Museum National D'Histoire Naturelle, Paris, has very kindly sent a co-type of *Paraprotomyzon multifasciatus* in exchange. This material has enabled us not only to assess correctly the systematic position of the two genera but also to redescribe *Protomyzon whiteheadi* and to give some of the salient internal characters of the fish.

If one studies Hora's key to the genera of the *Gastromyzoninae* one will notice that the *Gastromysonian*-group is sub-divided on the basis of (i) the union or separation of the pelvic fins, (ii) form and extent of mouth, (iii) extent of the pectoral fin in relation to the pelvics and (iv) the presence or absence of the flap of skin between the bases of the pelvic and pectoral fins. Judged on these characters, both *Protomyzon* and *Paraprotomyzon* fall in the subgroup characterized by the presence of free pelvic fins, *i.e.*, not united to form a disc-like structure. In the two other genera of this subgroup, namely *Pseuodgastromyzon* and *Sewellia*, the pectoral fins extend considerably beyond the origin of the pelvics. In this respect, *Paraprotomyzon* is allied to them while *Protomyzon* diverges from them. If we now examine the members of the second subgroup, in which the pelvics are united to form a disc-like structure, we get the same two divisions on the basis of the extent of the pectoral fins—*Beaufortia*, in which the pectorals extend beyond the origin of the pelvics, and *Neogastromyzon* and *Gastromyzon*, in which they do not reach the bases of the pelvics but the middle portion of the body between their bases is laterally stretched into skin flaps.

The geographical distribution of the Gastromyzonian-group of genera also shows that the extention of the pectoral fins beyond the origin of the pelvics is characteristic of the forms found in China and Cochin China and that in all the three Bornean genera, the pectorals do not reach the pelvics. It would thus appear that the union of the pelvic fins into a disc-like structure has probably occurred independently in China (*Beaufortia*) and in Borneo (*Gastromyzon* and *Neogastromyzon*) and that there is no direct genetic affinity between the groups of genera from these distant regions.

If the above argument is tenable, it then follows that *Protomyzon*, *Neogastromyzon* and *Gastromyzon* provide one evolutionary series, whereas *Pseudogastromyzon*, *Paraprotomyzon* and *Beaufortia*, with *Sewellia* as a side branch, form another series of progressive evolution. There is no doubt that the ancestors of all these forms were *Nemachilus*-like fishes, which in stronger and stronger currents, became more and more flattened and used the anterior rays of the pectoral fins for adhesion while the posterior rays were kept in motion to expell the water entering underneath the fish as has already been observed in the case of *Balitora*

and *Hemimyzon*[1]. This habit must have gradually led to an increase in the number of rays in the pectoral fins to subserve dual functions, and this is actually the case in more highly specialized genera.

The water pumped out by the pectoral fins would flow with greater speed at the sides of the fish and would no doubt affect the pelvic fins. Usually, in most of the hillstream fishes, even when the form is subcylindrical and not greatly depressed or flattened, an appendage of varying length and form is developed in the axils of the pelvic fins so as to give the side a streamline revetment to the current. In these forms, in which the pelvics were only slightly removed from the pectorals, as must have been the case with the ancestral form of the Chinese genera, and the form became depressed for adhesion the pectorals extended over the bases of the pelvics. In such cases, the appendage became attached to the side and extended backwards to provide a streamline revetment to the current. In those forms, in which the pectorals were removed from the pelvics by a considerable distance, as must have been the case with the ancestral form of the Bornean genera, and the body form in the initial stages continued to be subcylindrical, as flattening of the ventral surface for adhesion proceeded, skin flaps developed between the two fins to prevent the scouring action of the currents produced by the pumping movements of the posterior, vertically directed rays of the pectorals.

Both from the point of view of functional morphology and geographical distribution, we are of the opinion that there is no direct relationship between *Protomyzon* of Borneo and *Paraprotomyzon* of Sze-Chuan. It is probable, however, that in both subgroups more primitive forms, linking these genera with *Nemachilus*, may yet be discovered.

As a large number of topo-types of *Protomyzon whiteheadi* are now available, it is proposed to redescribe the species so as to facilitate reference in future.

Protomyzon whiteheadi (Vaillant).

Homaloptera whiteheadi, Vaillant, *Nouv. Arch. Mus.* V, pp. 92-94.

1916. *Homaloptera whiteheadi*, Weber & de Beaufort, *Fish. Indo-Austral. Archipel.* III, p. 13.

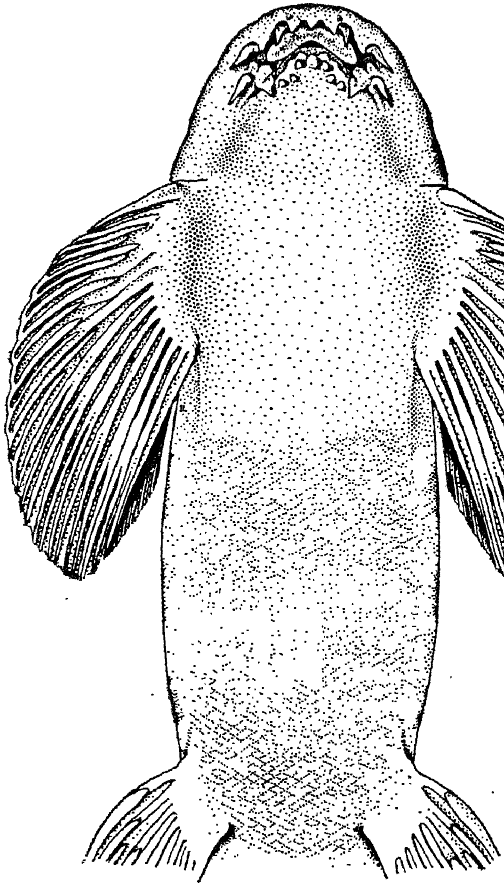
1932. *Protomyzon whiteheadi*, Hora, *Mem. Ind. Mus.* XII, p. 306.

D. 1/7 ; A. 1/6-7 ; P. 1/21-22 ; V. 1/9-10 ; C. 15-16.

Protomyzon whiteheadi is a loach-like fish with the head and the anterior part of the body depressed and ventrally flattened. The dorsal profile is but little arched. The length of the head is contained 5·5 to 6 times in the total length and its height is slightly less than that of the length of the snout. The snout is broad and rounded and is free from any tubercles. In some young and badly preserved specimens, the snout is a bit sharp and angular towards the tip. The eyes are placed dorsolaterally and are small. They are in the middle of the head and are not visible from the ventral surface ; they are contained 2·5 to 3 times

[1] Hora, S. L. *Mem. Ind. Mus.* , p. 323 (1932).

from the tip of the snout and are 2 to 2·5 diameters apart. The nostrils are placed just in front of the eyes. The mouth is placed on the ventral surface and is bordered by fleshy lips; the upper lip is curved. The lower lip is beset with ten small papillae, which are not so clear in some young specimens. The rostral fold is produced into small fleshy prolongations. There are 2 pairs of rostral barbels and a pair of maxillary barbels, all of which are very small. At each angle of the mouth, there

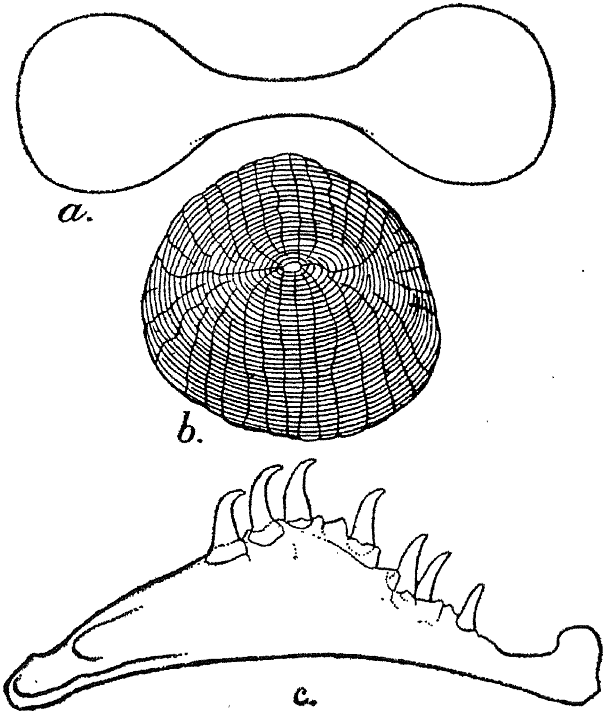


TEXT-FIG. 3.—Ventral surface of head and body of *Protomyzon whiteheadi* (Vaillant. × 3½)

are small fleshy prolongations, papilla-like in appearance. The gill-openings are small and do not extend to the ventral surface.

The origin of the dorsal fin is usually just above the origin of the insertion of the pelvics, and is nearer to the base of the caudal fin than to the tip of the snout. The pectoral fins are horizontally inserted and are provided with muscular bases; the inner rays being longer than the outer ones. Each fin possesses only one undivided ray. The outer rays are provided with pads on the ventral surface for adhesion while

the inner rays are directed upwards for pumping out the leakage water from underneath the ventral surface of the fish. The pelvics are also horizontally placed and do not reach the anal fin ; each fin is provided with about 9 to 10 rays of which one outer ray is simple. As in the case of the pectoral fins, some of the outer rays are padded for adhesion. The pelvics extend beyond the anal opening and are not united. In the axil of the pelvics, there is a small scaly appendage. The length of the pelvic fin is nearly equal to that of the longest ray of the dorsal fin. The anal fin is small and is inserted a short distance from the pelvics ; it just reaches the base of the caudal fin. The longest ray of the anal fin is 3 times the length of its base. There is no anal papilla. The



TEXT-FIG. 4.—Air-bladder, scale and pharyngeal teeth of *Protomyzon whiteheadi* (Vaillant).
a. Air-bladder × 22 ; *b.* Scale from below the dorsal fin × 57 ; *c.* Pharyngeal bone and teeth × 44.

least height of the caudal peduncle is about $1\frac{1}{2}$ times its length. The caudal fin is emarginate with the lower lobe slightly longer.

The body is loach-like, its depth is contained about 8 times in the total length. The body is covered with small scales, except on the ventral surface as far as the anal opening. The lateral line is complete.

A scale from below base of dorsal fin is oval and marked with numerous circuli and radii. The nucleus is eccentric and disorganised. There are sixteen complete circuli, and seventeen radii all round the The base of the scale is lobed and the top is broad,

In spirit specimens, the colour is dark brown marked with some irregular white patches in some specimens. The ventral surface is brownish. The dorsal and the caudal fins are brown or greyish, the base of the anal fin being provided with a dark spot.

The air bladder is bilobed and the two lobes are connected by a transverse tube. All the structures are enclosed by bone.

Measurements in millimetres.

Standard length	80	73	55	49	46	42	32
Length of head	12	12	10	9	8	8	7
Height of head at occiput	6	7	5	4	4	4	4
Width of head	10	11	8	7	7	6	5
Length of snout	6	6	5	5	5	4	3
Diameter of eye	2	2	2	2	2	2	1
Interorbital width	5	5	4	4	4	3	3
Depth of body	11	9	7	6	6	6	5
Length of caudal peduncle	7	7	5	4	5	5	2
Least height of caudal peduncle ..	5	5	4	4	3	4	3
Longest ray of dorsal fin	11	12	8	8	7	7	6
Length of pectoral fin	18	18	17	12	11	10	9
Length of pelvic fin	12	11	8	7	6	7	6
Longest ray of anal fin	9	9	6	6	6	6	4
Length of base of anal fin	3	3	2	2	2	2	2

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On Two New Gastromyzonid Fishes from Borneo.

By
S. L. HORA & K. C. JAYARAM.

CALCUTTA:
June 1951

ON TWO NEW GASTROMYZONID FISHES FROM BORNEO.

By SUNDER LAL HORA, *D.Sc., F.R.S.E., C.M.Z.S., F.A.S., F.N.I., Director,* and K. C. JAYARAM, *B.Sc., Assistant, Zoological Survey of India, Calcutta.*

The specimens under report formed part of a collection of fishes and other animals made by Mr. J. A. Griswold Jr. in the mountain streams of British North Borneo. The material is now preserved in the Museum of Comparative Zoology at Harvard, Cambridge Mass., U.S.A. The circumstances under which these Gastromyzonid fishes were found in this collection have been described by Hora,[1] with brief comments on the forms already known to science. On the basis of this material, the systematic positions of *Protomyzon* Hora and *Glaniopsis* Boulenger have been elucidated by Hora and Jayaram[2] in two short articles. Two specimens were found in the lot which appeared to represent new species, one belonging to *Protomyzon* and one representing a new genus allied to *Gastromyzon* Günther. These species are of great interest for the study of the phylogeny of the Gastromyzonidae and, therefore, they are described here inspite of the fact that each is represented by a single specimen.

We wish to record here our sincerest thanks to Dr. Henry B. Bigelow and Dr. W. C. Schroeder for making the entire collection of Gastromyzonid fishes available to us in Calcutta for detailed study.

Progastromyzon, gen. nov.

The new genus comprises small, flattened fishes, in which the snout is broad and rounded and is provided on the dorsal surface with short tubercles. The mouth is broad and transverse, and is bordered by fleshy lips. The posterior lip is fimbriated. The anterior lip is covered by a rostral hood which is notched in four places to accommodate the four short rostral barbels. There are two short maxillary barbels also, one at each corner of the mouth. The gill-openings are restricted to the dorsal surface, just extending to the bases of the pectoral fins. The paired fins are well-developed and horizontal. The pectorals possess 22 rays each, of which only one is unbranched. The pelvics have 10 rays each, of which only one is unbranched ; they are converging but not united to form a disc as in *Gastromyzon* and *Neogastromyzon*. Some of the anterior rays in both the fins are provided with adhesive pads. The body is covered with small scales which are much reduced on the ventral surface and are absent altogether between the bases of the pectoral fins. Behind the bases of the pectoral fins, there are narrow lateral extension of the body which are so characteristic of *Gastromyzon* and *Neogastromyzon*.

The new genus, as constituted above, represents a stage in the evolution of *Gastromyzon* ; their close similarity is evident from the form and

a, S. L. *Rec. Ind. Mus.* XLVIII, p. 50 (1950).
[2]Hora, S. L. & Jayaram, K. C., *Rec. Ind. Mus.* XLVIII, pp. 61-68 ; 85-88 (1950).

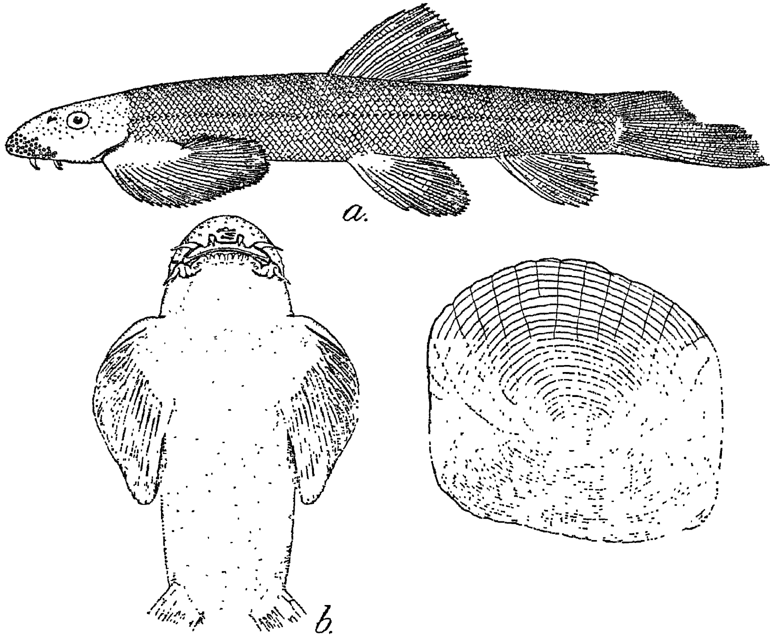
structure of the mouth parts. The differences lie in the disposition of the pelvic fins and the relative development of the lateral skin flaps.

Genotype.—Progastromyzon griswoldi, gen. *et*. sp. nov.

Progastromyzon griswoldi, gen. *et*. sp. nov.

D.3/8 ; A.2/5 ; P. 1/21 ; V. 1/9 ; C.18 (damaged).

For a description of the general features of the species, reference may be made to the description of the genus given above.



TEXT-FIG. 1.—*Progastromyzon griswoldi*, gen. *et* sp. nov.

a. Lateral view : × 1½ ; *b*. Ventral surface of head and body : × 2 ; *c*. Scale from below the dorsal fin : × 45.

The length of the head is contained 4·5 times and the depth of the body 6 times in the standard length. The height of the head is equal to the length of the snout. The eyes are dorso-lateral in position and are equal to one-third the length of the snout. The interorbital distance is equal to 2·5 times the diameter of the eye. The nostrils are situated close to the eyes and are fairly conspicuous.

The origin of the dorsal fin is slightly in advance of that of the pelvics and is nearer to the base of the caudal fin than to the tip of the snout. The pectorals are provided with muscular bases, which are devoid of scales ; they are separated from the pelvics by a distance nearly equal to half of their length. The pelvics are almost as long as the head and do not extend as far as the anal fin which just misses the caudal fin. The caudal peduncle is almost as long as high.

The lateral line is complete. There are 79 scales along it, 9 above it to the base of the dorsal fin and 9 below it to the insertion of the pelvic fin. A scale from below the base of the dorsal fin and above the lateral line is slightly longer than broad with a horizontal basal portion and a rounded apical portion. The nucleus is small and well-defined; it is considerably nearer the base than the apex. There are 36 circuli and 38 radii, of which only 17 reach the centre. In general structure, the scale is similar to that of *Gastromyzon borneensis*[1] though the latter is more elongated with the apex more conical.

The colour in spirit is olivaceous brown above and yellowish below. The upper surface of the head is greyish and the fins light grey.

Locality.—Kina Balu Mountain, British North Borneo.

We have great pleasure in naming this species after Mr. J. A. Griswold Jr., whose collection has enabled us to elucidate several points in the taxonomy and systematics of the Gastromyzonid fishes of Borneo.

Holotype.—No. CMZ 34806, Museum of Comparative Zoology, Harvard College, Harvard, Cambridge Mass., U.S.A.

Protomyzon borneensis, sp. nov.

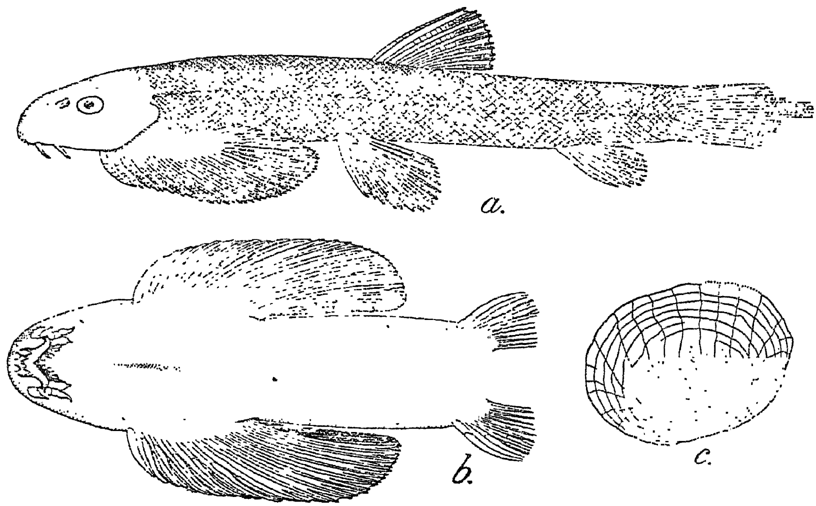
D. 1/6; A. 2/4; P. 1/22; V. 1/8; C. 18 (damaged).

Protomyzon borneensis is a small, loach-like Gastromyzonid fish in which the dorsal profile is only slightly arched and the ventral profile is horizontal throughout. The head and the anterior part of the body are greatly depressed and flattened. The length of the head is contained 4·5 times and the depth of the body 8 times in the standard length. The head is not as high as the length of the snout. The snout is smooth and broadly pointed. The eyes are small and dorso-lateral in position; the diameter of the eye is contained 2 times in the length of the snout and 1·5 times in the interorbital width. The nostrils are prominent and are situated just before the eyes. The mouth is small and lunate; it is situated on the ventral surface considerably behind the tip of the snout. The lips are fleshy and continuous; the upper lip overhangs the mouth and is papillated. The rostral fold does not cover the anterior lip and is produced into finger-like processes. There are two pairs of short, stumpy rostral barbels and a pair of maxillary barbels at each corner of the mouth. The gill-openings are restricted to the dorsal surface and extend as far as the bases of the pectoral fins.

The origin of the dorsal fin is slightly behind that of the pelvics and is nearer the base of the caudal than the tip of the snout. The pectorals are well-developed, are longer than the head and are provided with strong muscular bases; they are horizontal with several anterior rays acting as organs of adhesion. They are separated from the pelvics by a considerable distance. The pelvics have converging bases but are not united to form a disc-like structure. Only one ray of the paired fins is simple. The pelvics extend beyond the anal opening but are separated from the anal fin by a great distance. The anal fin misses the base of the caudal. The caudal peduncle is slightly longer than deep.

[1]Law, N. C. *Rec. Ind. Mus.*, XLVIII, p. 81, pl. iv, fig. 10(1950).

The scales are small and closely set. There are about 77 scales along the lateral line and 11 rows above and 14 rows below it. The ventral surface in front of the anal opening and the fleshy bases of the pectoral fins are devoid of scales. The structure of a scale from below the dorsal fin and above the lateral line is very different from that described by Law[1] for *Protomyzon whiteheadi*. The scale is small and more or less rounded, but the nuclear area is disorganised and there are only 6-7 circuli. There are 30 radii of which only 15 reach the disorganised central mass. Law has regarded this disorganization of the scales as a character of specialization. On this criterion, *Protomyzon borneensis* would appear to be more specialized than its only other congener *P. whiteheadi*. This state of affairs is parallelled by the scale structures of *Balitora brucei brucei* (disorganized scale) and *B. b. burmanicus* (less specialized with well-defined scale structures). It may here be noted that the scale of *Parhomaloptera* of Borneo (*vide* Law, *loc. cit.*, p. 79, pl. iv, fig. 12) shows great affinity to the disorganised scale of *P. borneensis*. In the structure of the mouth and its associated parts, the two forms show great resemblance and it is likely, therefore, that *Parhomaloptera* and *Protomyzon* are derived from the same ancestral stock.



. 2.—*Protomyzon borneensis*, sp. nov.

a. Lateral view: ×2 ; *b.* Ventral surface of head and body. › *c.* Scale from below the dorsal fin: ×62.

The colour in spirit is olivaceous grey above with the head portion somewhat darker. The ventral surface is pale olivaceous. The fins are greyish.

Locality.—Kina Balu Mountain, British North Borneo.

Holotype.—No. CMZ 34801, Museum of Comparative Zoology, Harvard College, Harvard, Cambridge Mass., U.S.A.

[1]Law, N. C. *Rec. Ind. Mus.* XLVIII, p. 80, pl. iv, fig. 6 (1950).

Relationships.—The new species can be readily distinguished from *P. whiteheadi* by the possession of two barbels at each corner of the mouth (*versus* one), by the absence of scales on the ventral surface in front of the anal fin (*versus* scales extending upto a short distance behind the bases of the pectorals) and by the structure of the scales (compact and well-defined in *P. whiteheadi versus* disorganised in *P. borneensis*). All these features and better developed paired fins indicate that the new species is more specialized than its only other known congener *P. whiteheadi.*

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note on the Systematic position of the genus *Glaniopsis* Boulenger (Fishes: Cyprinoidea).

By

S. L. Hora & K. C.

CALCUTTA:

A NOTE ON THE SYSTEMATIC POSITION OF THE GENUS *GLANIOPSIS* BOULENGER (FISHES : CYRINOIDEA).

By SUNDER LAL HORA, *D. Sc., F. R. S. E., C. M. Z. S., F. R. A. S. B., F. N. I., Director*, and K. C. JAYARAM, *B. Sc., Assistant, Zoological Survey of India, Indian Museum, Calcutta.*

Though the genus *Glaniopsis* Boulenger has generally been included in the family Homalopteridae, Hora[1] expressed doubts about its systematic position and regarded it a Cobitid rather than a Homalopterid fish. He based his conclusions on an external examination of the only two known specimens of the monotypic genus in the British Museum. During his recent visit to the U. S. A., in the Museum of Comparative Zoology at Harvard College, Cambridge Mass., Hora found a large collection of fishes made by Mr. J. A. Griswold from Mount Kina Balu, Borneo. Several hundred specimens from this collection had been correctly identified as *G. hanitschi* Blgr. and placed in the collection among the Homalopteridae. Through the kindness of Dr. William C. Schroeder, a large number of specimens have now become available for study at Calcutta and an opportunity has, therefore, been taken not only to discuss the systematic position of the genus but also to redescribe the species from abundant material with some details of internal structures.

Glaniopsis hanitschi Boulenger.

1899. *Glaniopsis hanitschi*, Boulenger, *Ann. Mag. Nat. Hist.* (7), IV, p. 228.

1900. *Glaniopsis hanitschi*, Hanitsch, *Journ. Straits Branch Roy. As. Soc.* No. 34, p. 75, pl. ii, figs. 2, 2a.

1916. *Glaniopsis hanitschi*, Weber & de Beaufort, *Fish. Indo. Austral. Archipel.* III, p. 5.

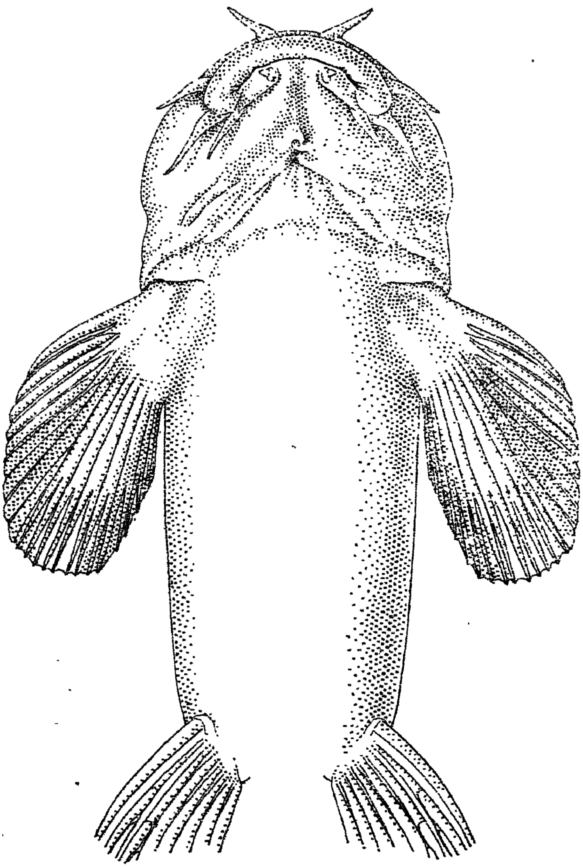
1932. *Glaniopsis hanitschi*, Hora, *Mem. Ind. Mus.* XII, p. 268 (foot-note).

D. 2/6-7 ; A. 1/6 ; P. 1/8-11 ; V. 1/7-8 ; C. 16-17.

In its general facies, *Glaniopsis hanitschi* is a *Nemachilus*-like loach with a broad head and slightly depressed body. The dorsal and the ventral profiles are almost horizontal or slightly arched. The head is short and broad ; it is scarcely longer than broad. The length of the head is contained from 5·0 to 5·75 times in the total length. The head is greatly depressed and smooth ; the snout is broad and rounded. The eyes are small and dorso-lateral in position ; they are in the middle of the head and are not visible from below. They are contained 5 to 8 times in the length of the head, 2 to 4 times in the snout and 2 to 3 diameters apart. The nostrils are nearer to the eye than to the tip of the snout and are separated by well-developed nasal barbels. The mouth is arched and its gape is equal to half the width of the head ; it is situated slightly behind the tip of the snout on the ventral surface

1. Hora, S. L. *Mem. Ind. Mus.* XII, pp. 267, 268 (1932).

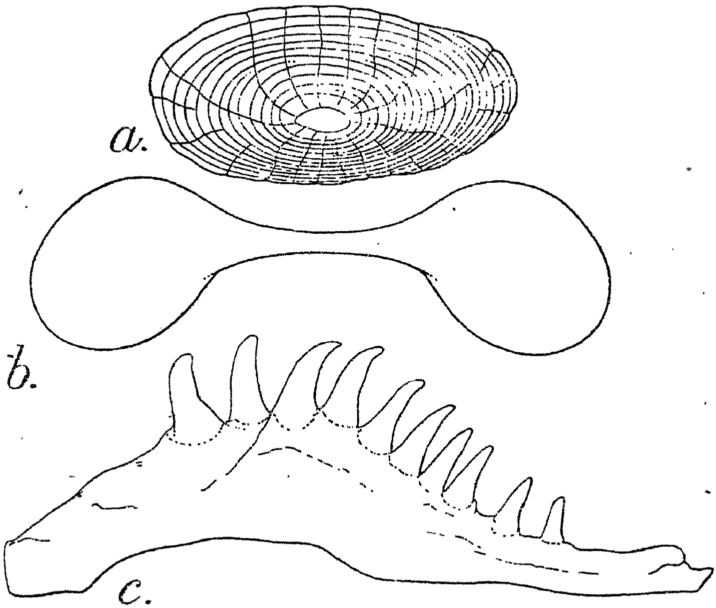
and is bordered by thick, fleshy lips. The lips are continuous at the angles of the mouth, but the lower labial fold is broadly interrupted in the middle. There is a deep groove round the corners of the mouth and there are two barbels on each side at this place. Besides, there are the usual maxillary and outer mandibular barbels. The inner edge of the labial fold of each side is also produced into a short barbel. The upper jaw is beak-like with a corresponding depression in the lower jaw. The gill-openings extend to the ventral surface for a considerable distance, the isthmus being equal to half the length of the head.



TEXT-FIG. 1.—Ventral surface of head and body of *Glaniopsis hanitschi* Boulenger: $\times 3\frac{1}{3}$.

The origin of the dorsal fin is usually slightly behind that of the pelvics and is nearer to the base of the caudal fin than to the tip of the snout; its longest ray is considerably shorter than the head. The pectoral fins are horizontally placed and are provided with muscular bases; they are as long as the head and possess only one undivided ray each. The first five rays are covered with adhesive skin pads on

their ventral surfaces, while the remaining eight rays are progressively more and more directed upwards so as to pump out water entering on the ventral surface, a feature very characteristic of the Gastromyzonid and Homalopterid fishes. The pectorals are separated from the pelvics by a considerable distance—almost half their own length. The pelvics are also horizontally placed with their posterior basal margins approaching each other. There is no free appendage in the axil of the pelvic fins. They are separated from the anal fin by a distance equal to their own length. The anal opening is situated at the tip of a papilla-like growth which lies in a depression in front of the commencement of the anal fin. The anal fin misses the base of the caudal fin. The least height of the caudal peduncle is almost equal to its length. The caudal fin is almost as long as the head, with the free posterior margin lunate; the upper portion is slightly longer than the lower.



.. 2.—Air-bladder, scale and pharyngeal teeth of *Glaniopsis hanitschi* Boulenger. *a.* Scale from below the dorsal fin : ×11 *b*; Air-bladder : ×11 *c*; Pharyngeal bone and teeth : ×22.

The body is loach-like; its depth is contained from 7 to 8·5 times in the total length. The body is covered with small scales, except on the ventral surface as far as the origin of the anal fin. The lateral line is complete.

A scale from below the lateral line is oval and marked with conspicuous circuli and radii. The nucleus is eccentric, being situated nearer the base than the apex. There are nine, well-spaced circuli, and 25 radii all round the scale. The circuli and the radii form a beautiful basket-work. In their structure, the scales deviate but little from the Cobitid type.

In spirit specimens, the dorsal surface is olivaceous brown, marked with transverse dark brown bands, spots or interrupted bands. Head is dark olive above. The ventral surface is whitish. The dorsal and the caudal fins are greyish ; the latter is provided with a blackish base. There is a dark mark in the axil of the pelvic fin. The other fins are olivaceous, somewhat lighter below.

The air-bladder is bilobed and the two lobes are connected by a transverse tube. All the structures are enclosed by bone. It is of the type usually found in *Nemachilus* and other hill-stream Cobitid fishes.

Systematic Position.—In its general form and structure, *Glaniopsis* differs little from *Nemachilus* and allied Cobitid genera, but in its greatly depressed head and anterior part of body, and the division of the pectoral fin into an adhesive outer portion and a vibrating inner portion, it shows an advance over the Cobitidae and approaches the Gastromyzoninae. *Glaniopsis* could thus be considered as a less specialised in the Gastromyzonid group of fishes.

Table of measurements in millimeters.

Standard length	97	86	83	74	70	69	63	59	53	45	42	33
Length of head	18	16	16	15	12	12	12	11	11	9	8	
Height of head at occiput ..	9	8	9	6	6	6	7	5	6	5	4	
Width of head	16	13	13	12	11	10	10	8	8	7		
Length of snout	9	7	7	5	5	5	5	4	5	3		
Diameter of eye	2	2	2	2	2	2	3	2	2	1		
Interobital width	7	8	7	5	5	5	5	4	5	4		
Depth of body	11	10	10	10	10	10	10	8	7	6	5	4
Length of caudal peduncle ..	4	3	4	2	2	3	2	2	2	3	2	1
Least height of caudal peduncle	9	8	9	7	7	6	7	5	5	5	4	3
Longest ray of dorsal fin ..	16	14	18	12	12	11	11	10	9			
Length of pectoral fin ..	17	15	15	12	14	12	11	11	10			
Length of pelvic fin ..	15	13	11	10	11	10	9	8	8			
Longest ray of anal fin ..	14	11	11	10	9	9	8	9	7			
Length of base of anal fin ..	6	4	5	4	4	[illegible]	4	4	3		3	2

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Respiratory and other adaptive modifications in the genus *Gyrinocheilus* Vaillant and their significance in constituting the family Gyrinocheilidae Hora.

By

K. C. Jayaram.

CALCUTTA:
1951.

RESPIRATORY AND OTHER ADAPTIVE MODIFICATIONS IN THE GENUS *GYRINOCHEILUS* VAILLANT AND THEIR SIGNIFICANCE IN CONSTITUTING THE FAMILY GYRINOCHEILIDAE HORA.

By K. C. JAYARAM, *B.Sc., Zoological Survey of India, Indian Museum, Calcutta.*

INTRODUCTION.

The remarkable genus *Gyrinocheilus* was established by Vaillant[1] in 1902 for *Gyrinocheilus pustulosus* from Borneo. In 1906, Berg[2] described *G. kazanakoi* from a part of South-eastern Thailand, now in Cambodia. The first fish, *Psilorhynchus aymonieri*, referable to this genus was, however, described by Tirant[3] in 1883, but as he placed it in the genus *Psilorhynchus* McClelland and gave poor description and figures, no notice of it seems to have been taken by later workers, until Hora[4] in 1935, having obtained photographs of the type-specimen, preserved in the Museum of Natural Sciences of Lyons, was able to decide that it was not a *Psilorhynchus* but a *Gyrinocheilus* identical with *G. kazanakoi* Berg.

The systematic position of the genus remained a matter of controversy for a long time. Vaillant referred it to the subfamily Homalopterinae and Boulenger [5] opined that it should represent a separate subfamily. Berg had erected a subfamily Gyrinocheilini to accommodate it, in 1906.

Regan [6], in 1911, however remarked that the place of *Gyrinocheilus* "in the system seems to be in the family Cyprinidae next to *Crossocheilus* and *Discognathus*". He also added, "to make it the type of a separate family or subfamily would merely obscure its relationships". Weber and Beaufort [7], included it in the family Cyprinidae without any comment. Hora[8], in 1923 erected the family Gyrinocheilidae for this genus and stated that:

> "There seems to be little doubt that judging from their appearance the members of the genus *Gyrinocheilus* are remarkably similar to those of the genera *Crossocheilus* and *Garra*, but this outward similarity, in my opinion, is directly correlated with the life of these fishes in moderately rapid running waters. The presence of "the slender toothless lower pharyngeals", the structure of the scales, the remarkable modification of the gill-openings to form inhalent and exhalent apertures and the

[1] Vaillant, M. L., *Notes Leyden Mus.* XXIV, pp. 107-122, figs. 30-32, pls. i-ii; *Comp. rd. Acad. Sci.* CXXXV, p. 702 (1902).

[2] Berg, L. S., *St. Petersberg Trav. Soc. Nat. Compt. Rend.* XXXVII, pp. 305-307; *deutsches Re's* 364-366 (1906).

[3] Tirant, *Bull. Soc. Etudes Indochines*, p. 35 (1883).

[4] Hora, S. L., *Rec. Ind. Mus.* XXXVII, pp. 459-461, figs. 2 (1935).

[5] Boulenger, G. A., *Camb. Nat. Hist.* VII, p. 582 (1909).

[6] Regan, C. T., *Ann. Mag. Nat. Hist. Soc.* VIII, (8), pp. 29-30 (1911).

[7] Weber and Beaufort, L., *Fish. Indo-Austral. Archipel.* III, p. 224 (1916).

[8] Hora, S. L., *Journ. Nat. Hist. Siam Soc.* VI, p. 159, pl. xii (1925).

structure of the mouth, lips and jaws are in my opinion better defined characters than those that seperate Cyprinidae, Cobitidae and Homalopteridae from one another."

Hora's fixation of the position of the genus has not so far been questioned and later workers, such as Berg[1] and Smith[2], have accepted the family in their systems of classification. Jordan[3], however included *Gyrinocheilus* under the family Homalopteridae.

A search through literature reveals that nothing further has been done to evaluate Hora's findings. The genus deserves thorough treatment and the elucidation of its affinities will definitely throw more light in understanding the systematics of other allied genera.

Dr. Hora placed at my disposal some specimens of this interesting genus which enabled me to work out the systematic position and details of some internal organs of *Gyrinocheilus*. A comparison of *Gyrinocheilus* with other allied genera, the respiratory and other adaptive modifications that form its family characteristics, its internal anatomy and their important details are given in the following pages.

The work was carried out in the laboratories of the Zoological Survey of India, under the guidance of Dr. S. L. Hora. I am highly indebted to him for his help, guidance, encouragement and supervision. I have examined 15 specimens of *Gyrinocheilus aymonieri* (Tirant) from Siam, now preserved in the collection of the Zoological Survey of India, Calcutta.

Air-bladders of *Garra*, *Crossocheilus* and *Gyrinocheilus*.

In the classification of Cyprinoid fishes, the form and structure of the air-bladder are regarded as characters of great taxonomic value. The genus *Gyrinocheilus* cannot be assigned to the Homalopteridae as it possesses a well-developed air-bladder lying free in the abdominal cavity. In this respect, it agrees with the true Cyprinid fishes, but we may compare the structure of the bladder here, in the genera *Garra*, *Crossocheilus* and *Gyrinocheilus* supposed to be closely related by Regan.

Hora (1923, *loc. cit.* p. 160), gives the following description of the air-bladder of *Gyrinocheilus* which fits in with almost all the specimens that I have examined :

> "The anterior chamber is almost circular in outline and has very thin walls, but is covered by a thick fibrous coat which attaches it firmly to the body wall; just at its termination the pneumatic duct from the oesophagus opens into the bladder. This chamber is followed by a short narrow tube, which dilates into another chamber, behind which the bladder is continued as a narrow cylindrical tube to its termination. The walls of the last three parts are moderately thick."

The narrow tube that connects the two dilated chambers is about half the length of the anterior chamber. In the case of *Garra*, the form of the air-bladder varies among its species and even among the different individuals of the same species. In all the less modified species of *Garra*, such as *adiscus*, *rossicus*, *blanfordi* and *rufus*, the bladder is of

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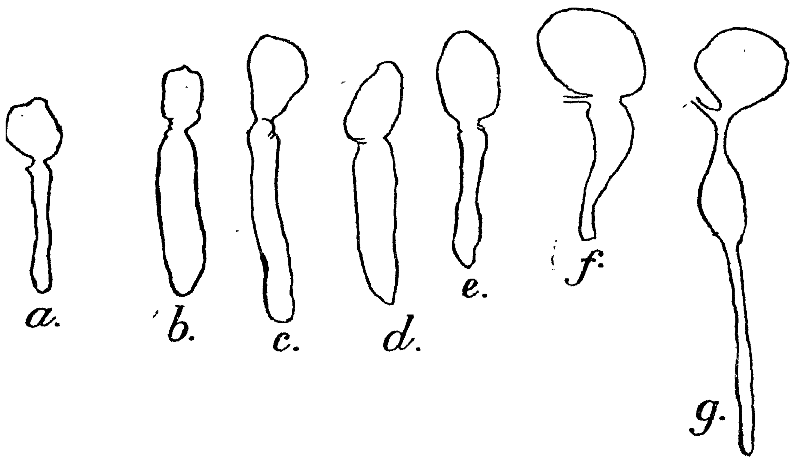
[1] Berg. L. S., *Classification of fishes both recent and fossil*, p. 269, 445 (1947). English and Russian, J. W. Edwards, Ann. Arbor, Michigan, U. S. A.

[2] Smith, H. M., *Bull. U. S. Nat. Mus.* (188), pp. 281-286 (1945).

[3] Jordan, D. S., *Stanford. Univ. Publn. Biol. Ser.*, III, p. 145 (1923).

the normal type generally present in the Cyprinidae, such as *Labeo* and *Cirrihina*. The anterior chamber is smaller than the posterior and is in the form of a short massive cylinder. The posterior chamber is almost as broad as the anterior and thence it gradually tapers to the end. But in the specialised species of *Garra* such as *gravelyi, jenkinsonianum* and *mullya* and in *Crossocheilus*, the posterior chamber, instead of being swollen in the middle is of uniform thickness throughout, with its wall somewhat thickened. In still more specialised forms such as *stenorhynchus, arabica, gotyla, nasutus* and *lissorhynchus* the whole of the bladder is greatly reduced and is covered by a thick, fibrous coat and is firmly fixed to the body wall. In some species the posterior chamber is greatly reduced and its cavity almost obliterated. (After Hora[1].)



:G. I.—Comparative drawings of the air-bladders of the various species of *Garra Crossocheilus* and *Gyrinocheilus* ("after Hora") ×⅘
a. Garra mullya; *b. Garra jenkinsonianum*; *c. Garra gravelyi*; *d. Garra mullya* hill-stream form; *e. Crossocheilus latia*; *f.* and *g. Gyrinocheilus aymonieri.*

The air-bladder of *Gyrinocheilus* would thus appear to be almost like the specialised species of *Garra* and *Crossocheilus*. In all these forms, the posterior chamber shows great reduction and the walls are thickened. The air-bladder of *Gyrinocheilus* is more reduced than that of *Crossocheilus*, but is larger than those of the more highly specialised species of *Garra*.

A comparison of the drawings of the air-bladders of the various species given here show the trend of modifications in these fishes. Judging by this character alone, *Gyrinocheilus* is definitely assignable to the true Cyprinid stock.

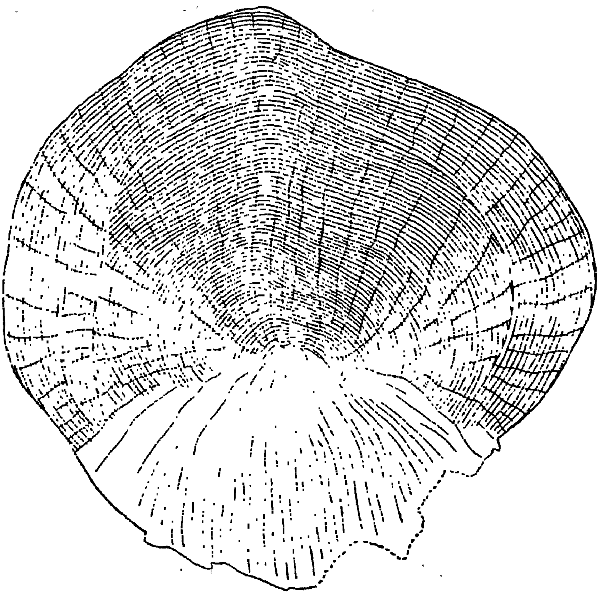
STRUCTURE OF SCALES IN *Gyrinocheilus, Garra* AND *Crossocheilus*.

A scale from below base of dorsal fin was taken in each case and studied. The scale of *Gyrinocheilus* is oval in shape with an undulating margin. The basal region is more conical than the top. The top portion

[1] Hora, S. L., *Rec. Ind. Mus.* XXII, p. 546 (1921).

is lobed and the scale is compressed laterally. The nucleus is in the center. There are about 40 or 50 circulii and about 40 to 45 radii. Only about 40 of them reach the center.

The scale of *Garra* resembles that of *Gyrinocheilus* in shape and structure. The nucleus is almost near the center, though not exactly so. The radii and the circulii are also disposed of as in that of *Gyrinocheilus*. The scale of *Crossocheilus* is more or less like that of *Garra* and *Gyrinocheilus* in outline but the apex is a bit conical. The nucleus is eccentric and is towards the base. The radii and the circulii are comparatively lesser in number. The scale of *Gyrinocheilus* is thus more allied to *Garra* than to that of *Crossocheilus*. Judging by this character also, the genus is assignable to the true Cyprinid stock of fishes.



TEXT-FIG. 2.—Drawing of a scale from below base of dorsal fin of *Gyrinocheilus aymonieri* × 18.

ALIMENTARY CANAL OF *Gyrinocheilus*.

The alimentary canal of *Gyrinocheilus* has been fully described and figured by Vaillant. (1902, *loc. cit.*, pl. I and II.) The oesophagus and the stomach are bent in the form of a U. The intestines are coiled up and gradually tapers towards the caecum.

The late Dr. H. M. Smith informed Dr. Hora, that the fish feeds on algae and slime and that it scrapes encrusting material with the help of its jaws. The belief that the peculiar lips are used for scooping up mud on which the fish is supposed to feed is erroneous; and actually the fish scrapes algae from rocks. The contents of stomach and intestines were found to consist of amorphous vegetable matter in a number of specimens.

THE GILL-OPENINGS AND GILL-RACKERS.

The branchial openings are modified in a remarkable way. "Each gill-opening is divided into an upper slit-like portion, which serves as an inhalent opening and communicates with the posterior part of the mouth cavity immediately in front of the gills and a lower much wider portion which serves as an exhalent aperture and is guarded by a large membranous flap," as remarked by Hora[1].

The gill-rackers of *Gyrinocheilus* are set close together and prevent the scrapped food from being carried out with the respiratory current.

RESPIRATORY AND OTHER ADAPTIVE MODIFICATIONS.

Gyrinocheilus is a herbivorous fish and its jaws are adapted for scrapping algae from stones and other submerged objects. The lips act as a sucker for the fish to maintain itself in running water by adhering to stones. It has been observed that even in an aquarium tank in still water, the fish attach themselves to the bottom or to the vertical glass front. Inasmuch as this fish uses its suctorial mouth for maintaining its position, it would seem that it has lost all its ability to breathe like ordinary fishes and always relies on its inhalent pores for the inspiratory current. For this purpose the mouth is ventral in position in order to facilitate its attachment of the lips to the substratum.

Smith[2] has observed that the amount of water which may enter the branchial opening is limited and in order to secure sufficient oxygen, the fish breathes in very rapidly. Observations made on these fishes up to 12 cm. length in a large aquarium, have proved that their respiratory rate is 230 per minute as evidenced by the movements of the opercular flaps. It is believed that the respiratory current is initiated and carried by the opercular flaps.

Gyrinocheilus lives in torrential streams as well as in swamps. This habitat might be responsible for the large eyes and better marked colouration and body form.

DISCUSSION.

The above noted details and comparisons show one particular point. The genus *Gyrinocheilus* resembles *Garra* and *Crossocheilus* in the disposition and modification of the air-bladder and the structure of the scales, thereby sharing with them the true Cyprinid characters. But it is unique in the modification of its gill-opening into an inspiratory and expiratory channels, which has not been met with in any of the Cyprinoid fish. Usually the trend in all members of the hill-stream fishes of the family Homalopteridae is the reduction of the gill-openings to a minimum but not a complete physiological severance from the mouth. Even in extreme cases, the water is sucked in through the mouth and let out through the greatly reduced gill-openings. But in *Gyrinocheilus* the mouth serves little purpose in the respiratory mechanism of the fish. This is a great modification and a remarkable characteristic feature, peculiar only to this genus among the Cyprinoid fishes.

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[1] Hora, S. L., *Jour. Bomb. Nat. Hist. Soc.*, XXXVI, pp. 549-550 (1933).

[2] Smith, H. M., *Jour. Nat. Hist. Siam Soc. N. H. Suppl.* VIII, pp. 11-14 ; 187-189 (1931).

The structure and dentition of the pharyngeal bone are characters of great taxonomic value in Cyprinoid fishes. Toothless, slender-pharyngeal bone of *Gyrinocheilus* are sufficiently diagnostic for separating it from other families of Cyprinoid fishes.

The discontinuous geographic distribution of the genus is also significant. It is found in Siam and Borneo and is absent from the Malay Peninsula, Sumatra and Java. In all probability the ancestral stock evolved on the mainland, probably in Siam and then went down to Borneo *via* the shallow South China Sea, when there was a land bridge in this region. The genus appears to be much younger than *Garra* or *Crossocheilus* in age for they are very widely distributed, even extending to Africa. Whatever may be the pattern of dispersal, it is clear that it never migrated *via* the so-called Malayan arch passing through the Malay Peninsula and Sumatra. Zoo-geographical considerations would also favour the separation of the genus from its parental stock.

In view of the various considerations advanced above, I am of the opinion that *Gyrinocheilus* should stand separate from other Cyprinoid fish as the sole representative of the family Gyrinocheilidae Hora.

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Notes On two Homalopterid fishes from Szechuan, China.

By

K. C. Jayaram.

CALCUTTA:

1951.

NOTES ON TWO HOMALOPTERID FISHES FROM SZECHUAN, CHINA.

By K. C. JAYARAM, *B.Sc., Zoological Survey of India, Indian Museum, Calcutta.*

INTRODUCTION.

During his visit to the U. S. A. in 1949, Dr. S. L. Hora, studied the Homalopterid material preserved in several natural history museums of the U. S. A. and has already made a brief report[1] on it. Among the fishes he examined in the Museum of Zoology, University of Michigan, he found one specimen of *Hemimyzon* Boulenger and one of *Sinogastromyzon* Fang which, for want of time, he could not study in detail there, but requested their loan in order to examine them in Calcutta. Through the kindness and courtesy of Dr. Reeve M. Bailey, Curator of Fishes, these specimens were received in Calcutta, in May 1950. As Dr. Hora was then preparing for an expedition to the Western Himalayas, he very kindly entrusted the material to me for detailed investigation. He has now checked my results and helped me in the preparation of this article. I am grateful to him for his guidance and generous help.

The two specimens under report formed part of the Chinese collection of Dr. Cora D. Reeves and according to the information recently supplied by her they were purchased from the markets of Chengtu and Kiating, Szechuan. Kiating is a small city at the junction of two mountain streams to form the first branch of the Yangtse above Chungking. To Dr. Bailey she wrote :

> " I went up to Chungking on a larger river steamer for Kiating that evening and came into that port at the head of the steam-boat navigation the next day. I haunted the small fish market for a day or two and picked up the fish from there. The fish from Chengtu I also got by looking over what the fishermen found and brought into the market."

The specimens are in an excellent state of preservation. Dr. Hora had already referred the *Hemimyzon* specimen to *H. abbreviata* (Günther) provisionally and detailed examination confirms his identification. The *Sinogastromyzon* specimen was regarded by him as a likely new species. He stated :

> " 57 scales along the lateral line, 10-11 rows between the lateral line and the base of dorsal, 21 predorsal scales ; P.12/12 ; V.6/12-13 ; two rows of prominent papillae on the anterior lip, the posterior lip is crenulated there are two barbels at each angle of the mouth.' (Hora, 1950, *loc. cit.*).

When the above characters are evaluated against the known range of variation in the scale-counts and number of fin rays, the specimen falls well within the limits of *S. szechuanensis* to which Dr. Bailey had already assigned it when forwarding

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[1] Hora, S. L., *Rec. Ind. Mus.* XLVIII (1), pp. 45-58 (1950).

the specimens. Both the specimens under report differ, however, from the earlier descriptions of the two species in certain respects and as very few specimens belonging to these species are known in the museum collections, notes on certain features showing variations are given below for convenience of reference in future.

Hemimyzon abbreviata (Günther).

1892. *Hemimyzon abbreviata*, Günther, in Pratt's *Snows of Tibet*, p. 248.

1932. *Hemimyzon abbreviata*, Hora, *Mem. Ind. Mus.* XII, pp. 301-302, pl. xi, fig. 8.

D.2/6 ; P.11/11 ; V.3/11 ; A.2/5.

Material.—One specimen collected from Szechuan, Chengtu or Loshan (Min river drainage), Cora D. Reeves, about 1940, bearing No. U.M.M.Z. 15815 of the Museum of Zoology, University of Michigan.

The specimen agrees in all important characters with the description of *Hemimyzon abbreviata* given by Hora.[1] The number of pectoral and pelvic rays and the dorsal fin formula does not quite exactly fit in with that of *H. abbreviata*. In this specimen, only 2 rays of the dorsal fin are simple instead of 3 and the pectoral and pelvic fins possess 22 (11/11) and 14 (3/11) rays respectively *versus* 24 and 15 as given by Hora in his description of the species.

Measurements in millimeters.

Total length including the caudal ..	103·0
Length of caudal fin	24·0
Length of head	17·0
Width of head	13·0
Height of head at occiput ..	7·0
Length of snout	10·0
Diameter of eye	2·0
Interorbital width	7·0
Breadth of body in front of pelvic fin	18·0
Height of body in front of dorsal fin	10·5
Length of caudal peduncle ..	16·5
Longest ray of dorsal fin ..	21·0
Longest ray of anal fin.. ..	15·0
Length of pectoral fin	23·0
Length of pelvic fin	18·5

Sinogastromyzon szechuanensis, Fang.

1930. *Sinogastromyzon szechuanensis*, Fang, *Contr. Biol. Lab. Sci. Soc. China* (Zool. Ser.), VI, pp. 99-103 (Szechuan, no definite locality).

1944. *Sinogastromyzon szechuanensis*, Chang, *Sinensia* XV, p. 53 (Luhsien and Chengtu, Szechuan).

1949. *Sinogastromyzon szechuanensis*, Chen and Liang, *Quar. Journ. Taiwan Mus.* II, p. 163 (Omei, Szechuan).

As the distinguishing characters of the 5 species included under this genus very much overlap, it is proposed to describe this specimen in detail with figures so as to facilitate reference in future.

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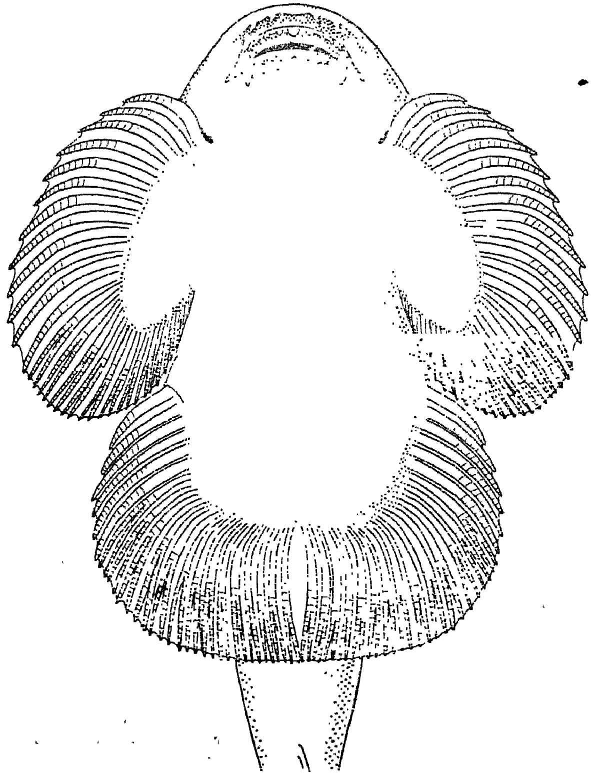
[1] Hora, S. L., *Mem. Ind. Mus.* XII, pp. 300-302 (1932).

D.3/9 ; P.12/12 ; V.6+2/12 ; A.1/5.

The head and the body are dorso-ventrally depressed with the ventral surface greatly flattened. The dorsal profile is but slightly arched. The length of the head is contained 5·3 times in the total length and its height is only half its length. The snout is broad and rounded and is free from tubercles. The eyes are placed dorso-laterally and are not visible from the ventral surface ; they are contained 3 times in the length of the snout and are about 1·5 times apart. The nostrils are placed just in front of the eyes and are fairly conspicuous. The

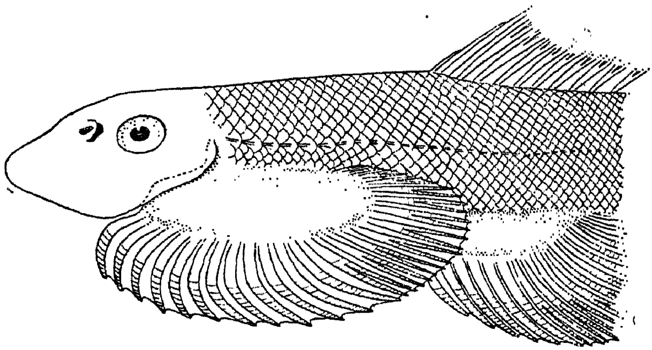


TEXT-FIG. 1.—Ventral view of *Sinogastromyzon szechuanensis*. Note the number of simple and branched says in the pectoral and pelvic fins ×2.

mouth is placed on the ventral surface considerably behind the tip of the snout ; the jaws are bordered by papillated lips ; the upper lip has nine small papillae. There are 4 small barbels in the notches on the rostral fold, in front of the anterior lip. There is a pair of barbels at each angle of the mouth, the outer one being longer and stouter. The gill-openings are small and restricted above the bases of the pectoral fins.

The origin of the dorsal fin is just behind the insertion of the pelvics, and is nearer to the tip of the snout than to the base of the caudal fin. The pectoral fins are horizontally inserted and are provided with *muscular bases which are free from scales*; the inner rays being longer than the outer. Each fin is composed of only twelve undivided rays. The outer rays are not padded. The pelvics are also horizontally placed and form a disk-like structure on the ventral surface. They extend beyond the anal opening but do not reach the base of the anal fin. The pelvics are provided with muscular bases, which are naked. The anal fin is small and is inserted a short distance from the pelvics. It does not reach the base of the caudal fin. The longest ray of the anal fin is twice the length of its base. It is provided with a papilla. The least height of the caudal peduncle is about one-third of its length.

The depth of the body is contained about 7·3 times in the total length. The body is covered with small scales which are keeled; they are absent on the ventral surface as far as the anal opening. The lateral



TEXT-FIG. 2.—Lateral view of *Sinogastromyzon szechuanensis*, showing the naked muscular bases of the pectoral and pelvic fins. Note the extent to which the muscular bases are naked ×2.

line is complete. A scale from below base of dorsal fin is small and oval in outline. The circulii and radii are very inconspicuous. The nucleus is eccentric and disorganised.

In spirit, the colour is brownish and is marked with irregular dark patches. The ventral surface is pale olivaceous.

The present specimen differs from Fang's description of *szechuanensis*[1], in the following characters :—

1. Vent with papilla and placed equidistant from bases of pelvics and origin of anal fin, *versus* nearer bases of pelvics than origin of anal fin.

2. The number of scales along the lateral line is 57 *versus* 64 in

3. The pectoral fin possesses only 12 branched rays *versus* 13 in

[1] Fang, P. W., *Contr. Biol. Lab. Sci. Soc. China* VI (9), pp. 99-103 (1930).

4. The pelvic fin possesses only 20 rays (8/12) *versus* 21 rays (6-8/15-13).

5. The upper lip has only one row of 9 papillae *versus* 11 in *szechuanensis*.

The above-noted differences would have justified the retention of the present specimen as a separate subspecies, if Chang had found these differences constant in the 4 specimens he reported upon from Luhsien and Chengtu. His specimens were 64-67 m.m. in standard length and gave the following counts for fin-rays and scales :—

D. 3/8 ; A. 2-3/5 ; P. 23-25 (11-13/12-13) ; V. 20-22 (5-6+2-3/12-13); L. 1. 61-64 ; L. tr. 11/8-9-A.

Material.[1]—A single specimen : No. U.M.M.Z. 15816, Museum of Zoology, University of Michigan, Ann Arbor, Michigan, U. S. A.

Measurements in millimeters.

Total length including the caudal fin	80·0
Length of caudal fin	17·0
Length of head	15·0
Width of head	15·0
Height of head at occiput ..	7·5
Length of snout	9·0
Diameter of eye	3·0
Interorbital width	5·0
Breadth of body in front of dorsal fin	11·0
Breadth of body in front of pelvics	16·0
Length of caudal peduncle ..	15·0
Least height of caudal peduncle ..	5·5
Longest ray of dorsal fin ..	15·0
Longest ray of anal fin ..	10·0
Length of base of anal fin ..	5·0
Length of pectoral fin	24·0
Length of pelvic fin	23·5

[1] Fang, P. W., *Sinensia* II, (3), pp. 48-53 (1931).

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Rising Salinity o -Evidence

DR. SUNDER LA
Director, Zoological S

In this contribution the learned author discusses one of the major problems affecting the river Hooghly from a new and interesting angle, and generally supports the conclusions arrived at by Sri S. C. Mazumdar in his contribution on the Ganga Barrage, appearing in our Second Annual Number.—Editor.

It is generally believed that the salinity of the river Hooghly has increased considerably during recent years. But a correct appraisal of the situation is made difficult by the absence of adequate early salinity records. Even the recent records available with the Calcutta Port Commissioners and the Calcutta Corporation authorities are mostly of the surface and sub-surface samples taken with no special reference to the tide conditions. In the absence of such direct evidence, we could have had little actual proof of the magnitude of salinity changes, were it not for the data available from the records of fish distribution in the river. Study of the fauna which reacts sharply to permanent hydrological changes is of immense help in such circumstances. The very valuable data relating to the historical changes in the salinity of the Missisipi river, obtained by the study of the occurrence and fishery of the American oyster *Crassostrea virginica* (Gmelin) may be cited as an example.

Hooghly and its Fishes in the Past

The extent of the brackish water zone of the Hooghly was, till recent years, much less than what it is today. Even in the later part of the last century, the water in the river near Calcutta was fresh and potable. This was the reason for the location of the intake station for the water works at Palta, which was then much above the salt water zone. Dr. Francis Hamilton, who made extensive collections of fishes from 1798 to 1814 from the Hooghly, both at Calcutta and lower down, has given a comprehensive list of the fish fauna of this region in his remarkable work, "*An Account of the Fishes found in the river Ganges and its branches*". From this account it can be seen that the fauna of the river near Calcutta consisted of purely freshwater forms, except for the anadromous species, the Hilsa *Hilsa ilisha* (Hamilton) for instance, that ascend up into fresh water for spawning. In the early part of this century, effects of rising salinity began to be felt in the higher reaches of the river and the river water was no more fresh. The salinity at Palta rose sometimes to as much as 62.5 parts per hundred thousand or even more. The writer conducted an investigation of the Hooghly in the year 1937 for the Calcutta Corporation and from the results of this study it was evident that the composition of the fish fauna had changed very considerably, correlated with the increase in salinity in the bottom layers. Marine species of flattened bottom fishes, such as *Platycephalus indicus* (Linnaeus) and *Cynoglossus lingua* (Hamilton), were found to have migrated into the river and some of the burrowing gobies, such as *Pseudapocryptes lanceolatus* (Bloch & *Apocryptes bato* (Hamilton) and *Odontamblyopus rubicundus* (Hamilton), which normally inhabit the lower estuaries, had extended their distribution to the higher reaches. The presence of bottom fishes of marine and estuarine groups, far inland above tidal influences clearly showed that a bottom wedge of brackish water was penetrating up the river, especially during the hot and dry months. As is fairly well known, a large or a deep river joining the sea has a bottom layer of saltwater, which extends up-stream in a wedge of diminishing thickness until it is entirely replaced by fresh water. As the fresh water is much lighter than sea water, it forms a layer over the salt water; but the layer gets gradually thinner as the force of the flow of the river water is lessened by the effect of tidal currents, etc. It is largely dependent on the volume and force of the fresh water brought down from above. Through this brackish water, tidal wedge, it becomes easy for bottom dwelling marine and estuarine animals to migrate up-river and colonise the higher reaches. It was thus possible for us even in 1938 to trace a wedge of salt water at the bottom of the river upto Naihati and even above.

Present State of the River and the Fish Fauna

From recent studies the salinity of the Hooghly water made at each and Cossipore, it is found that the is progressively increasing and the present salinity is than what it was some years before. Clo correlated with this fact, changes in the fish fau een reported. In a Symposium on Hi at Calcutta last year under th Indo-Pacific

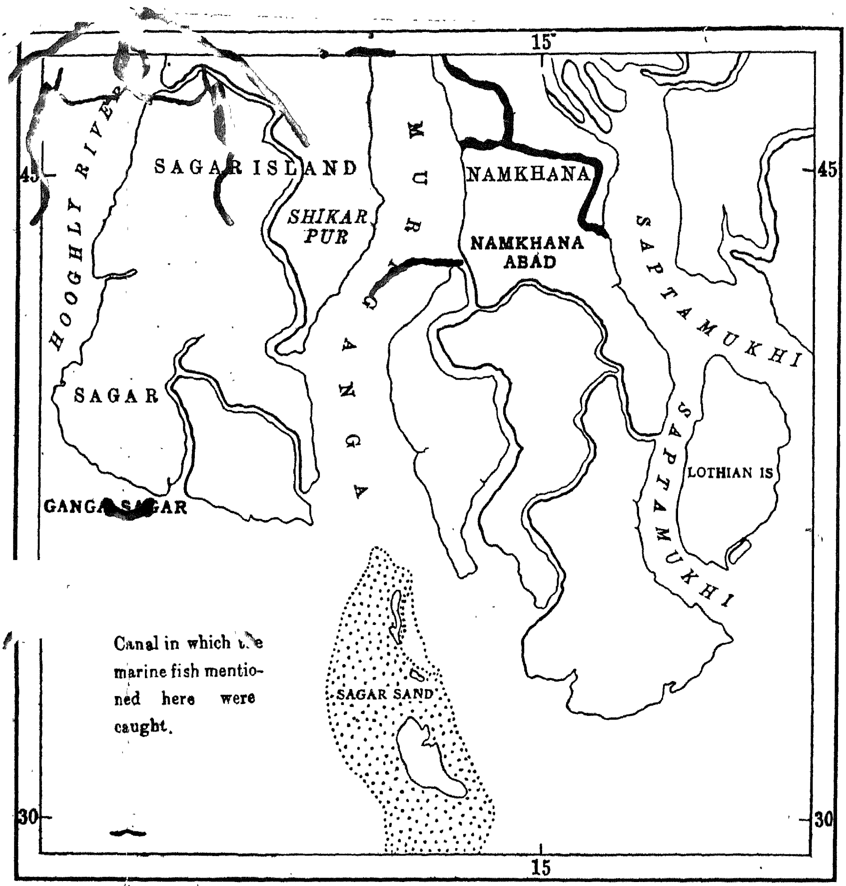
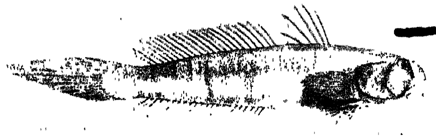


FIG. 1. Map showing the area from where the marine fishes were caught in large numbers.

Council of the Food and Agriculture Organization of the United Nations, the writer pointed out that varieties of Hilsa, different from the one generally fished from the Hooghly, have begun to appear in these waters. Recently, it was observed that a fish, not found in the Hooghly till a couple of years back, is being caught in large numbers in the river upto about Falta, that is upto a distance of nearly 80 miles from the mouth of the river. This fish known to scientists as *Hilsa toli* has been given the name *Kajal Gouri* ("Black Beauty") and *Mukh Phora* ("Burnt face"), presumably on account of the black colouration of its body, especially the snout. It is a purely marine fish in Indian waters a[illegible]s not so far been observed to ascend rivers. Its presence in the Hooghly estuary, as far up as Falta, now appears indicative of the very great increase in the salinity of the estuarine waters and the development of conditions very similar to that of the sea [illegible] areas. One notable fact is that [illegible] ishes reported by the writer in his early investigations, this is a pelagic fish living in the surface and sub-surface zones. The probable reason is that the magnitude of the tidal wedge in the river has now increased to such an extent that the layer of freshwater on the surface has become very much reduced and surface forms are able to migrate up the estuary. Further immigration of pelagic fishes into the Hooghly estuary has also come to notice.

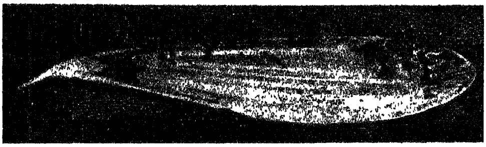
The writer has recently been informed by some fish dealers in Calcutta, who have been in the trade for a number of years, that they now get several types of marine fishes from the fishermen's catches in the Sundarbans. Two notable fishes among these are the *Pomfret* (*Pampus argenteus*) and the Seer (*Scomberomvous guttatus*), which used to be brought only occasionally into Calcutta markets from the catches of fishermen on the Orissa Coast. During the current season, appreciable numbers of these fishes have been caught near Pather Pratime, south of

Burrowing forms : *Apocryptes lanceolatus* (Bloch & Schneider).

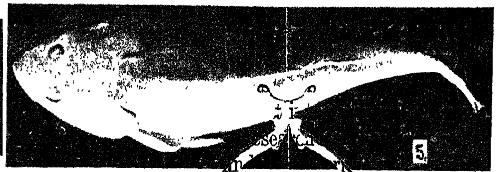


Burrowing forms : *Apocryptes bato* (Hamilton).

Burrowing forms : *Odontamblyopus rubicundus* (Hamilton).



Flattened forms: *Cynoglossus lingua* (Hamilton).



Flattened forms : *Platycephalus indicus* (Linnaeus).

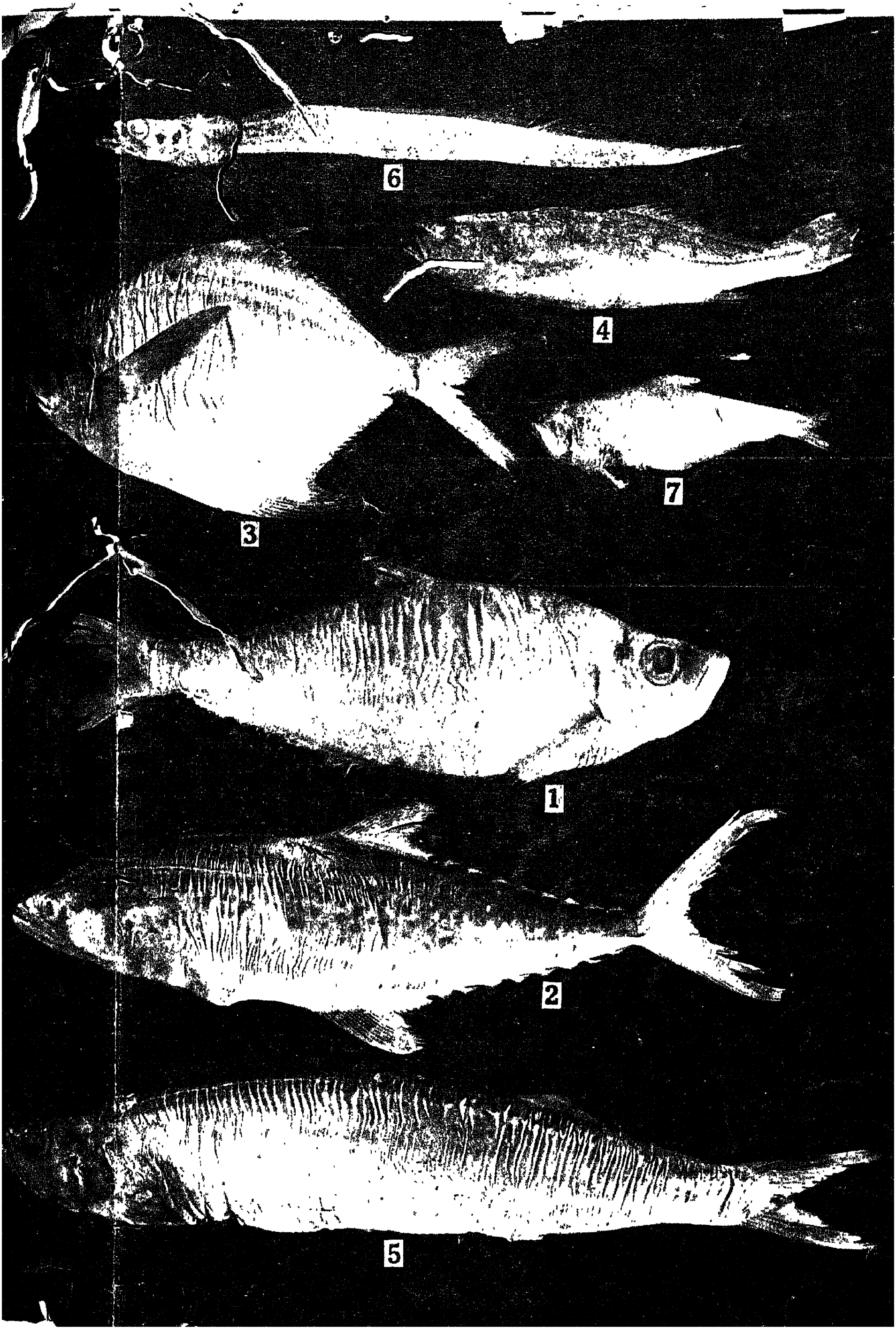
FIG. II. The bottom fishes that were observed to have migrated into the River Hooghly as high up as Naihati during the survey in 1937.

Diamond Harbour. Specimens of these have also been obtained from Falta and Diamond Harbour. Other fishes now commonly caught by the estuarine fishermen are "Lakshman Chela" *Ilisha filigera*, "Chuncho Bhola" (*Otolithus ruber*), "Ramchela" (*Chirocentrus dorab*), "Rupopati" (*Tridhiurus haumela*), and "Phensa" (*Setipinna breviceps*). None of these have been recorded by Dr. Hamilton in his book on the *Fishes of the Ganges*. It appears probable that these fishes have migrated into the estuary during recent years. Though the exact distribution of the species in the Hooghly has yet to be investigated, the available information indicates that they are mostly restricted to the estuary below Falta.

Need for Intensive Survey

The close correlation between the salinity of the river and the fish fauna clearly shows the necessity for a thorough resurvey of the fish fauna of both the bottom and surface zones of the river. Such a survery is likely to throw much light on the magnitude and range of the tidal wedge as also the salinity conditions of the river. The extreme usefulness of studying the behaviour of fishes is too obvious to be stressed here. It will also be of interest to correlate the fish survey findings with the investigations now being conducted in regard to training works to improve the channels of the Hooghly. It is likely that the rise in salinity has so far affected only the channels below the Port of Calcutta, where the cumulative effect of improved channels may be facilitating the influx of the sea water. An intensive biological survey of the river, as high up as Nadia and its tributaries may also yield very valuable information regarding the behaviour of the river under training works. It is urgently necessary, however, to set up salinity recording stations at suitable places in the lower reaches of the Hooghly estuary so that the threatened danger to the town of Calcutta can be sighted well in time to be averted. Improvement of head-water supply by the construction be the most suitabl of the river. The s in the river at vario to be an efficient means of asses nity changes in the river.

FIG. III. The pelagic fish, *Hilsa toli* (Valenciennes), which has migrated into the river Hooghly in recent years.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Fishery Problems of River Valley Projects in India, with Special Reference to those of the Damodar Basin*

by

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IT is after a lapse of eight years that I have to-day the privilege of addressing the members of the Research Committee of the Central Board of Irrigation and Power on the subject of fisheries in connection with the river valley projects which had received nation's highest priority during the first Five-Year Plan. No one to-day minimises the value of these projects, for some of them have already started yielding valuable results. It is not my intention to discuss the problems of conservation of fisheries of the rivers affected by engineering works because the merits and demerits of these have been discussed on several previous occasions and I have no doubt that they have begun to receive the attention of the authorities concerned. For instance, the Damodar Valley Corporation has not only a Fishery Section, manned by five technical persons besides other staff, under the Soil Conservation Division but has also a senior fishery biologist as Adviser. My object to-day is to bring to your notice some practical problems that have arisen in the course of developing fisheries of some of the reservoirs constructed so far and to seek your guidance in their solution.

FISH PASSES AND LADDERS

The members of the Committee will recall that the Indian Council of Agricultural Research had sought the help of the Central Board of Irrigation in 1944 in devising suitable fish passes for the Indian species of migratory fishes and the Board had asked for certain data† regarding the species concerned before the designing of any fish pass could be taken up. In pursuance of this exchange of views, a research scheme was put into operation in 1946-47 at the River Research Station at Galsi in West Bengal under the writer's supervision and with the help and assistance of Dr. N. K. Bose. The partition of the country soon after upset all our plans and the scheme was abandoned before any worth-while results could be obtained. To the best of my knowledge no further fishery biology research in connection with fish passes has been undertaken since and therefore, the experimental data required by the Board to design fish passes are still not available. However, a great deal of observational data is now available which goes to show that so far as

C. dams are not being provided with any Fish Passes or Fish Ladders. As the above is a bold statement contrary to what has been believed in and attempted so far, an analysis of the observational data will perhaps be not out of place here.

MIGRATORY FISHES OF INDIA

Fish Passes are designed all over the world to facilitate the movements of commercially important fishes across artificial barriers and therefore it is necessary to classify all Indian

*Presented at the 25th Annual Research Committee Meeting July, 1955.

† State, as far as known, the requirements of passes for each class (of fish), in respect of flow, between resting places, height of falls, entrances *etc.*"

fishes of this nature and understand their biological requirements. Migratory fishes of India can be divided roughly into three categories according to the nature of their migrations. These are : (1) Brackish Water Fishes moving into fresh waters for b eeding purposes, such as Hilsa, Hilsa ilisha (Hamilton). Some of the eels that move from fresh waters into seas for breeding purposes are not of any commercial importance to receive our consideration here: (*ii*) Mig atory Fishes of the Plains, mostly Ca ps and Catfishes and (*iii*) Migratory Fishes of the Hills, mostly large-scale Barbels, popularly known as Mahseers.

Water Fishes—

Hilsa is the only fish of commercial importance that needs any consideration under this category. Fortunately since 1937, much information has become available on the movements, probable races, breeding, feeding and fishery of Hilsa. In fact, all this information is available in a "Symposium on Hilsa" published in the Science Series of the Journal of the Asiatic Society, Calcutta (Vol. XX 1954). This fish ascends from the foreshore and estuaries of all large rivers of India during floods for several hundred miles inland if there be no obstruction in its upward migration as in the case of the Ganga and Brahmaputra Rivers. But obstructions in the form of weirs and dams already exist in the case of the Cauveri, Krishna and Godavari Rivers. Though Hilsa fishery has certainly suffered in these south Indian rivers through engineering obstructions, in my opinion it would not have been possible to reconcile its with the needs of water for irrigation lro-electric purposes. This species is ely delicate, particularly in the mature conditions, and even obstructions by gill-nets are sufficient to kill it. It requires a regular flood for its upward migration and no engineer could possibly spare such large quantities of water from an irrigation project to sustain the fishery of this species. In the Damodar Basin, Anderson Weir at Rondia obstructs the upward movement of this fish so D.V C. authorities do not have the Hilsa problem to contend with in their fisheries programme.

I have stated above that Hilsa at present moves freely in the Ganga and the Brahmaputra river systems but a Ganga Barrage and several other schemes of harnessing the water resources of these rivers are under contemplation. There is no doubt that they would affect the very valuable Hilsa fishery but there is some evidence at present that a race of Hilsa has established itself in the middle reaches of these rivers. If further researches p o be a fact then some of the difficulties will be solved but the quality of the upper India race is not so good as that of the estuarine migratory race.

The above statements should not be taken to mean that there are now no problems of conservation of Hilsa fisheries below the obstructions for which a co-ordinated programme between engineers and fishery biologists is essential but as such a programme is necessary for all kinds of fisheries thus affected, I shall refer to it later.

Migratory Fishes of the Pl ains—

Fishes coming under this category are the Carps—Catla, Labeos, Cirrhinas, and the Catfishes, Pangas, Silond, Wallago and Ar. The fishery development of the Mettur Reservoir has conclusively shown that the fisheries of these fishes are not affected but through fish cultural practices and appropriate ha vesting techniques they could be improved considerably. The migratory movements of these fishes are of short distances only and if through stream improvement measures breeding grounds could be created for them below the dams, their fisheries could be improved still further. In the case of the Mettur Reservoir these fishes have become firmly established and breed in the feeder channels. In my opinion, further artificial stocking of this reservoir is not necessary.

The experience of Mettur is likely to be repeated in the Bhavani Sagar where Catla

other fish have been stocked for the first time and have already started yielding satisfactory crops.

The Bhavani and the Cauveri rivers are perennial and had permanent fisheries in them before any engineering works were undertaken. The engineering works must have done some harm to these permanent fisheries but the loss is not only likely to be fully compensated by the development of the reservoir fisheries but the fishery production of the river as a whole is likely to increase considerably.

The rivers of the Damodar Basin are, however, of the "Flashy" type quite different from the perennial rivers because they flow only during the flood season and run dry for the rest of the year. In these rivers, there are no permanent fisheries and the creation of reservoirs is thus a potential new source of fisheries. Only the Tilaiya Reservoir has been stocked so far and the growth of fishes is very satisfactory. Exploitation of fisheries is a difficult problem as there are no local fishermen but attempts are being made to develop new methods of fishing.

From the observations recorded above, it may reasonably be presumed that the fisheries of the migratory fishes of the plains are not likely to be affected by the engineering constructions but on the other hand may improve the fishery of the rivers as a whole in due course.

Migratory Fishes of the Hills

The various types of Mahseer, which are to be dealt with under this category, do migrate for breeding and feeding purposes within certain range of temperature of water. The successful stocking and establishment of the Golden Himalayan Mahseer in the Kumaon Lakes are proofs conclusive that these fishes could be grown and acclimatised in irrigation or hydro-electric reservoirs provided the temperate conditions remain within their range of [illegible] Mr. Langdale Smith of [illegible]liot Tea Estate in the Darjeeling kept and fattened Mahseers in a pond and made the Copper Mahseer, *Lissochilus hexagonolepis* (MaClelland) breed by setting a series of suitable ponds for them. The Copper Mahseer has even been stripped and its young ones reared for stocking purposes. The most remarkable feature of this species is that it can stand successfully conditions very different from those prevailing in hill-stream. The Directorate of Fisheries, West Bengal, has kept this fish in sewage irrigated fisheries near Calcutta where it has grown well and has been found useful for the control of weeds. It will thus be seen that though their movements will be obstructed by the setting up of engineering works in hill-streams, it seems probable all the same that potentiality of fish production of the stream could be increased through fish cultural practices and proper management of the reservoirs.

Conclusion

From the observations recorded above, it can safely be concluded for the general guidance of the irrigation and power engineers that fish passes or fish ladders are not required in making any plan for the construction of a dam, barrage, anicut or weir across an Indian river. There are, however, other fishery problems created by the river valley projects in which a co-ordinated approach from the engineers and fishery biologists is highly desirable. I shall now deal with some such problems.

OTHER FISHERY PROBLEMS

River a Biological Unit

When an authority undertakes the development of a river, it is necessary to take a stock of its biological resources along with other values so that a lopsided approach to the project is avoided. For instance, the D.V.C. authorities did not realize in the beginning that the fish reared in their reservoirs will move up into the feeder streams above the reservoirs during flood season, for breeding purposes and will thus be in the Bihar State territory where the Fishery Regulations will not apply.

when the undersluices are opened, some fishes are sucked out and soon get out of the jurisdiction of D.V.C. Though fishes have been cultured in the Tilaiya Reservoir, the proper management of the fishery can only be effective through the collaboration of the Bihar Government.

Reservoirs and Fisheries

Reservoir Bottom Obstructions—Whether the reservoirs become naturally stocked as in the case of perennial rivers or are artificially stocked as is the case of the Damodar Basin reservoirs, the main object is to exploit their fishery resources. If there are submerged tree trunks and villages, naturally fishing with nets will present serious p oblems. It is necessary, therefore, that before the reservoir is filled up, all such obstructions should be removed both in the interest of malaria control and fishery exploitation.

Reservoir Water Level—Recently the undersluices of the Tilaiya Reservoir were opened to lower the level of the reservoir and there was a great loss of fish which had been reared at considerable cost. The fishery staff was not informed of this and even if it had been informed the recovery of fish on any large scale from the torrential current that had been set up below the dam could not have been possible. One is justified to ask, could not a co-ordinated policy be evolved in such a case and discharge of water spread over a longer period in the interest of the fishery of the Reservoir? With a slow current fishes would not have been sucked out in such large numbers and even if they had gone through the undersluices, they would have escaped injuries and it would have been possible to catch a great many of them below the dam. Can electric screens be devised to keep away fishes from the suction current when undersluices are opened for lowering the level of the reservoir?

Prohibition for Fishing—It is a general habit among fishes that they move up stream and when their upward movement is obstructed by an engineering work, they accumulate in large numbers below such obstructions and thus fall an easy prey to the greed of fishermen. It is desirable, therefore, that for a distance of one mile below these obstructions no fishing should be permitted.

Stream Improvement—As the upward movement is generally for breeding purposes, the engineers should prepare a suitable scheme of stream improvement so that breeding grounds can be provided in side channels and the main stream bed both above and below the reservoir. A fishery biologist should assist in the formulation of such a scheme so that a co-ordinated effort is made in rehabilitating the original river fishery.

Exploitation of Fisheries

I have already referred to the great desirability of cleaning the bottom of the reservoirs to facilitate fishing operations. Even when this is done, fishing methods for deep reservoirs will have to be evolved. In the case of the Mettur Reservoir and the Bhavani Sagar, the use of Rangoon Nets, Wall Nets, and Long Lines has proved effective. These methods may also prove useful in other reservoirs led by perennial rivers on account of flow of water which suits the movements of fishes and turbidity of waters which prevents the visibility of nets even from a short distance. These two factors do not operate in the Tilaiya Reservoir with the result that fishing by Mettur fishermen with their own fishing appliances has not proved successful. A further factor not conductive to gill-net fishing at Tilaiya is the prevalence of strong winds. All these factors show that each Reservoir has its individuality and no rule of thumb can be applied towards their exploitation. Biological investigations of various types and some amount of experimentation would seem to be necessary before methods of exploitation could be standardised for each rese voir.

Methods of fishing with electricity have been tried in certain western countries, more or less on an experimental basis. Possibilities of the use of similar methods are now under investigation in the D.V.C. If any one of them proves commercially successful, it will

greatly help the fishery development of the many large sheets of water in India which cannot be exploited as at present.

Probable Fish Productivity of the Reservoirs

Rounsefell (Copeia, 1946, pp. 29—40) has used the figures of fish production in American lakes as a guide for estimating production in proposed reservoirs under the river-valley projects. He has thereby created a useful yardstick which, with suitable modifications, can be used in other countries as well. The most obvious characteristic of the yields is the rapid decline in production per acre per annum as the size of a lake increases. The yield per acre of a lake is generally correlated with the relative area of fertile shallow water, which is generally much less in proportion to total area in the larger lakes than in the smaller ones, as indicated by the difference in the length of the shore line. The production of a lake will also vary according to its physical and chemical conditions and also on the population of fish and other organisms present in the water. Rounsefell has indicated that

> "A reservoir usually differs in certain important feature from a natural lake. It is more subject to frequent and severe fluctuations in water level. It is more apt to have the bottom covered with layers of silt. The deep water usually is confined to one end, causing unnatural temperature stratifications. All of these features tend to make the reservoir less productive than the natural lake."

He has further stated that

> "Because of the large quantities of organic matter present when first flooded, reservoirs may show a high initial productivity which will be reduced within a short space of years when they have begun to approach as close to a state of equilibrium as a reservoir is likely to attain."

In preparing the following table, I have taken the maximum productivity figures as given by Rounsefell in view of the tropical conditions present in most parts of India and correspondingly rapid growth of fish. The Mettur fishery has shown that production can even be greater, but for rough estimates of production these figures will do till proper records become available.

Probable Fish Production in Indian Reservoirs

Area in acres	Production in Ponds acre per annum	Production per annum in maunds
10,000	95·99	11,706
20,000	98·03	19,024
30,000	62·81	22,977
50,000	51·26	31,255
1,00,000	36·08	44,000
2,00,000	27·23	66,414
5,00,000	19·44	1,18,535
10,00,000	14·52	1,77,070
20,00,000	11·15	2,71,956
50,00,000	7·72	4,70,732
1,00,00,000	5·90	7,19,501

NEED FOR FRESH WATER BIOLOGICAL STUDIES

Through the execution of the River Valley Projects the engineers of India are changing daily the geography of the country. By the use of stored water, vast biological resources in the shape of agricultural crops and animal husbandry products are being increased. The potentialities of fisheries have been discussed here. There is always a chain of events that leads to the biological productivity of waters. Comparing with our growing need for the understanding of equatic biology, it is sad to say that there is not a single Fresh Water Biological Station in the country worth the name. The Government of India is now

considering the setting up of one such station in the Damodar Basin, probably at Maithon, but each large river valley project should have a station from its very commencement. The cost of running such a station will be a fraction of one per cent of the total cost but overall advantages to the scheme will be many. I am convinced of this approach because I have seen that through the application of biological principles, the working of the Pulta Waterwork at Calcutta was considerably improved at practically no cost.

SUMMARY

Though no experimental biological data are yet available in regard to the migratory fishes of India to enable engineers to design suitable fish passes for the commercially important species, the author, on the basis of observational data, which are dealt with at some length, comes to the conclusion that in the case of Indian fishes of all categories fish passes are not required. The fishes of the plains and of the hills are capable of being reared in the reservoirs and thus the fish productivity of the river as a whole could be improved.

Among the other fishery problems, the author points out that a river should be treated as a single biological entity, the bottom of reservoirs should be cleaned to facilitate fishing operations, the lowering of reservoirs' level should be co-ordinated with fishery requirements, fishing for a mile below any obstruction should be prohibited, a programme of stream improvement, both above and below the reservoir should be undertaken to facilitate the breeding of fish, and problems of fishery exploitation should be co-ordinated with engineering requirements.

The author finally gives some idea of the likely fish production from the reservoirs and pleads for fundamental freshwater studies in order to make full use of the aquatic resources that are now being created through the implementation of river valley projects.

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THE SEVENTEENTH ACHARYA JAGADISH CHANDRA BOSE MEMORIAL LECTURE

BY

SUNDER LAL HORA

AND

DIRECTOR'S REPORT

PRESENTED TO THE 38TH ANNIVERSARY MEETING OF THE BOSE INSTITUTE ON 30TH NOVEMBER, 1955

CONFLICT *VERSUS* COOPERATION AS FACTORS IN EVOLUTION

The Seventeenth Acharya Jagadish Chandra Bose Memorial Lecture

By

Sunder Lal Hora

Director, Zoological Survey of India, Calcutta.

Ladies and Gentlemen,

It is a great honour and privilege for me to be invited to deliver the Acharya Jagadish Chandra Bose Memorial Lecture on the occasion of his birthday, as well as the foundation day of the Institute that bears his illustrious name. This Lecture is meant to commemorate his memory and all of us assembled here today, and many friends who cannot be with us, respectfully pay homage to this great son of India.

His main object in founding the Institute in 1917 was to continue his fundamental investigations on the similarity of the life phenomena exhibited by plants and animals, and also to train a band of devoted workers who would continue this line of research. The results so far achieved by the Bose Institute, both during his lifetime and since, have thrown a flood of light on different aspects of the problem through fundamental investigations from various approaches. Indeed, The Institute, under the inspired guidance of Dr. D. M. Bose, its present Director, has in recent years grown from strength to strength and I know you wish to join me, on this occasion, in offering our congratulations to the Management for its exceptional record in the past and our best wishes for the future.

My own indebtedness to Sir J. C. Bose is great, for I belong to a generation which had the good fortune to know him well. I worked with him for a year on the Executive Committee of the Indian Science Congress; and, when he was the General President of the Congress at Lahore in 1927, I was its Honorary Treasurer. On that occasion, I delivered a Public Lecture on "Animal Life in Torrential Streams" (Hora 1927), at which he presided. Nearly thirty years have passed since then, but I still remember with gratitude his stimulating remarks after the lecture. It interested him because I dealt with the reactions of the living organisms to the non-living physical factors in the environment

and discussed their harmonious blending in the scheme of life through "Adaptations".

His own philosophy, based on the experiments and reflections of a third of a century, was generalised in his Presidential Address to the Indian Science Congress in 1927 on "The Unity of Life". In all branches of science progress has been made by observations and generalisations. Without accurate and detailed knowledge of the facts and phenomena all theories become idle speculations, while the absence of the philosophic spirit, suggesting hypotheses of greater or less magnitude, renders the mere accumulation of facts an empirical and barren study. Like the Indian sages of old, Sir J. C. Bose richly combined a facility for precise observations with a gift for integrating them into philosophical generalisations ; but, whereas the old sages observed and generalised without leaving much indication of their methods, Sir Jagadish also had the additional gift of demonstrating his observational results through the extremely delicate instruments he was able to invent. In short, he was a rare personality in science, for he possessed a fertile imagination, remarkably clear inner vision, great inventive power, and experimental skill of the highest order.

The great value of Sir J. C. Bose's philosophy of the "Unity of Life" will be appreciated more and more as mankind increasingly comprehends that '*there must also be a unity of all human efforts and that in the realm of the mind there can be no boundaries and no separations.*' It is a misunderstanding of the Laws of Nature, he pointed out, '*to regard conflict as the only factor in evolution ; far more potent than competition is mutual aid and cooperation in the scheme of life.*' This prophetic outlook has now begun to be felt very keenly in all the nations of the world, and we are entering on an era when the possibilities of its expansion for the happiness and prosperity of the human race will know no bounds.

I have accordingly chosen as the subject of today's address "Conflict *versus* Cooperation as Factors in Evolution," firstly because it represents a small segment of Sir J. C. Bose's own philosophy, and secondly because my investigations on animal ecology for the better part of forty years have led me to similar conclusions.

Conflict in the Darwinian Theory

Darwin's theory of evolution, which, in a somewhat modified form, still dominates modern scientific thought, is based on "conflict" as a factor in Evolution. Its groundwork is provided by random variations playing against the background of the struggle for existence and survival of the fittest through Natural Selection. According to this theory, Nature is armed tooth and claw to weed out the unfit in the struggle

for existence. The selected variations must therefore be of a beneficial character to the animal concerned, though Neo-Darwinians deny any utilitarian aspect in organic evolution. As the utility of a structure can be judged only by reference to its functions in relation to the environment, it seems probable that adjustment between the organism and its environment, rather than conflict among organisms, is the potent factor in evolution. This view is supported by Sir J. C. Bose ; for according to him, '*Every organ of a living being is an instrument subserving a particular function for the advantage of the organism*'.

After studying animal life in torrential streams for over a decade, I was led to the following general conclusions :

> 'In studying the life and characters of the animals inhabiting the torrential streams of India and elsewhere, one thing has become quite clear to me—that evolution is no more than the adaptation of organisms to environment. "Adaptation" signifies correlation of an animal with its habitat and therefore the study of animal organisation, however detailed, cannot by itself lead to the proper understanding of this phenomenon. Environment, with its unlimited gradations, plays an important part in the making and re-making of the characters, and sometimes the resultant forms are of such totally different types that genetic relations can hardly be discerned. This fine adjustment of an organism to the external conditions of its existence is the result of a series of gradual changes *induced* by the environment'

Detailed field observations, and I hope some imagination and vision, led me to the above conclusions, but lack of invention and experimental skill have stood in my way in demonstrating what I have felt to be true. However, Dodds and Hisaw (1924) have discussed the adaptations exhibited by certain Mayfly nymphs of *Baetis* for life in swift currents, and have shown that a direct correlation exists between the swiftness of the current and the degree of reduction of the median caudal seta. *B. tricaudatus*, with 3 tail seta, lives in currents flowing at the rate of 5 feet per second ; *B. intermedius*, with a shorter middle seta, lives in waters flowing as fast as 8 feet per second ; and *B. bicaudatus*, with the middle seta vestigial, lives in places where the water flows at the rate of 10 feet per second (see Plate fig. 1). The reduction of the middle seta ensures proper streamlining of the body to present a streamline form to the swift current.

My *guru*, the late Dr. Nelson Annandale, felt very strongly that 'the long-continued and gradual influence of environment' produces adaptive characters and that 'evolution is ultimately no more than adaptation of organisms to environment.' He, too, was not able to demonstrate in some tangible way what he strongly felt to be true, but Sir J. C. Bose was able to prove experimentally the intriguing proposition '*that the mechanism of life of the plant is essentially similar to that of the animal*'. This example emphasises our need for more scientists with the capacities that Sir J. C. Bose possessed in such ample measure.

I agree entirely with Mr. Ritchie Calder that "The Fragmentation of Science" is making scientists into 'intellectual cripples'. There are very few scientists now who can interpret biological chain reactions against the physical factors of the environment, much less to demonstrate their interpretations in a convincing way.

Conflict *versus* Adjustment

The statements made above pose a question : should there, in the Darwinian sense, be a continuous conflict (Struggle for Existence) among organisms to ensure evolution, or could a continued adjustment of an organism to its environment, both physical and biological, lead to evolution ? As the basic factor in evolution is the origin of variations, we have to seek an answer as to how variations are produced and then perpetuated and strengthened, generation after generation, to establish a new race or species. The science of genetics has advanced to such an extent that, by chemical or electrical treatments of an organism, variations can be produced artificially, but the main point for consideration is that some change in the environment of the organism is always necessary to induce mutations. In nature, while an organism is still capable of growth, it responds to the new situations by a slight alteration of growth ; and, having thus responded, successfully hands over to the next generation an increased capacity to respond, which is continually increased generation after generation till it becomes firmly engraved on the hereditary power.

I agree with Professor MacBride that there are no random variations in the Darwinian sense, and that 'variation is due to the different efficacy with which the individual responds to the influence of the environment and that this is due to the varying amount of *vigour* possessed by the animal and that vigour is the one thing which varies continually (probably due, I think, to the position of the germ-cell in the genital organ and its varying amount of nourishment) and that natural selection chooses not the random variation but the individual which is most responsive to the environment.' (Quoted from a letter in my possession.) The point made by Professor MacBride is that one has not to consider the survival value of a character under study but of the individual as a whole, for an organism is a combination of many characters showing responses to unlimited factors in its environment.

Sir J. C. Bose expressed a comparable view when he pointed out, in his address on "The Unity of Life", that '*The evolutionary process has been active not only in morphological differentiation, that is, in the development of new forms, but also in physiological differentiation, that is, in the development of specialised mechanisms for performance of various vital functions.*'

PLATE

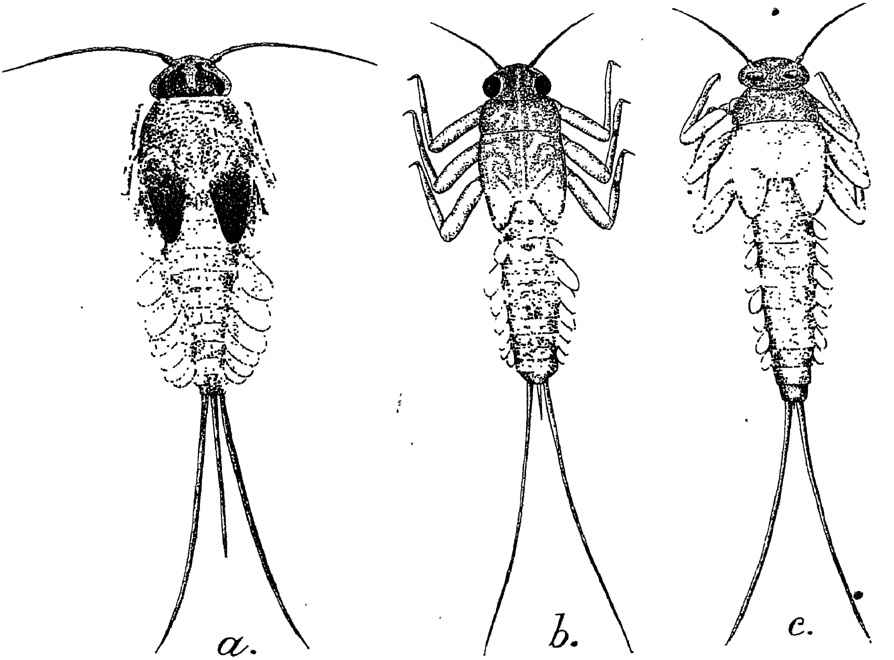


FIG. 1

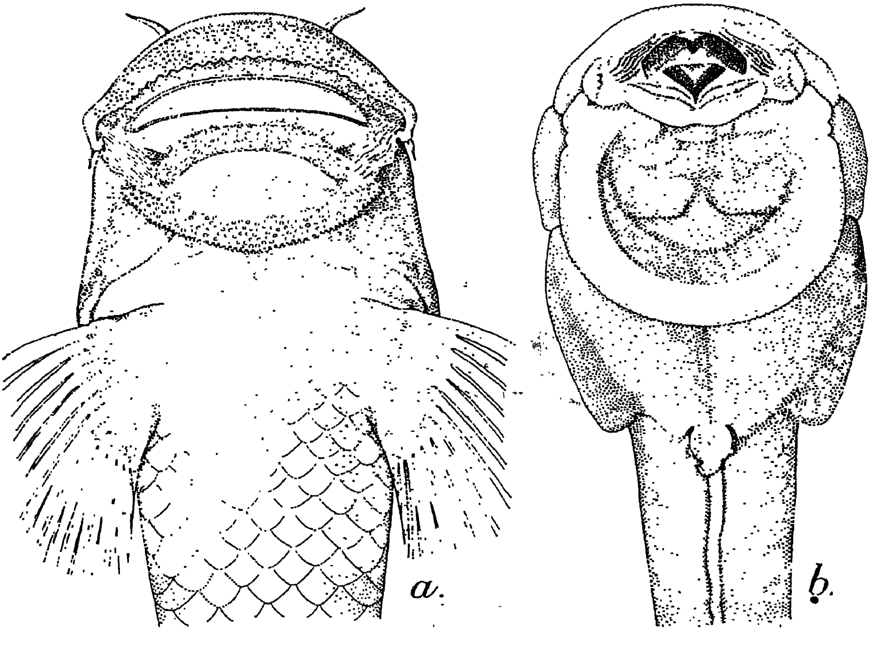
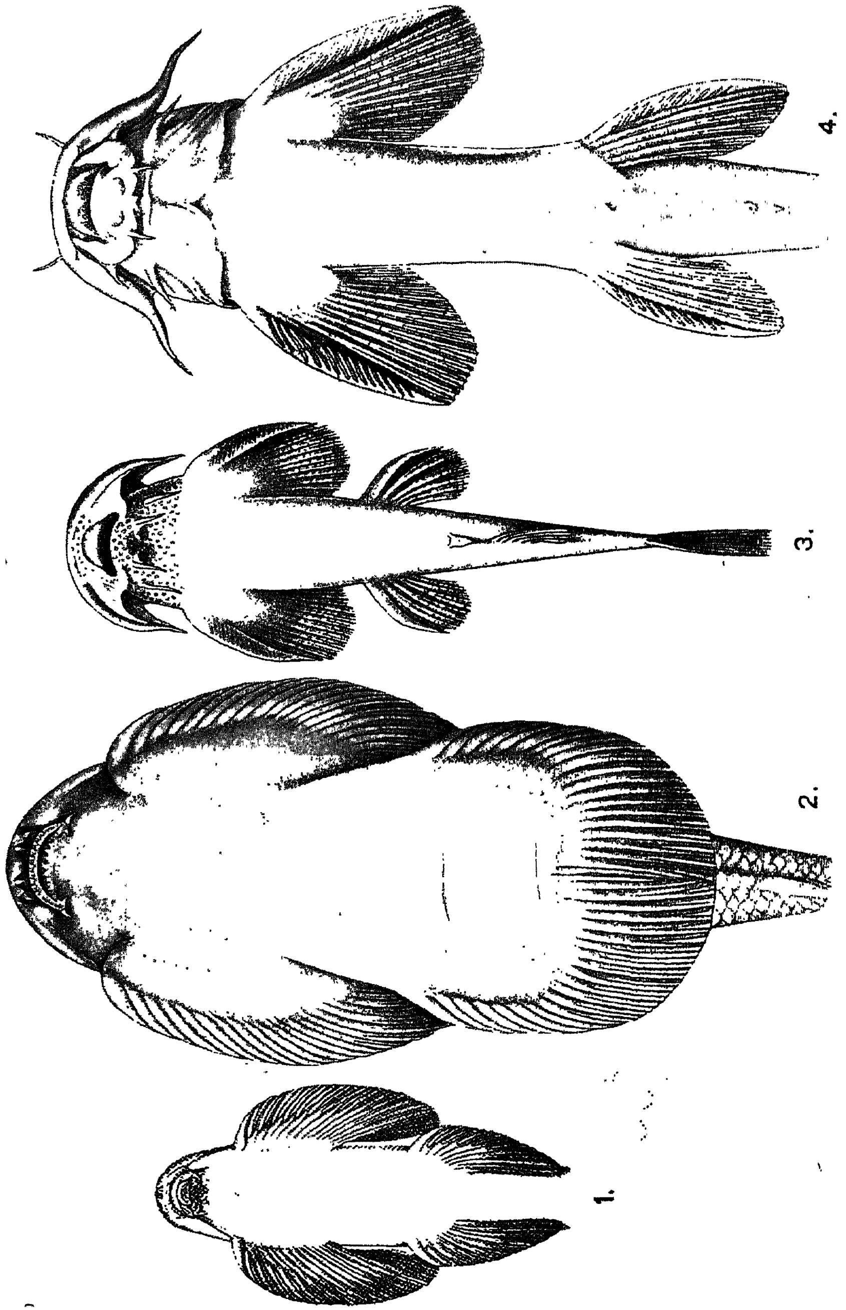


FIG. 2

PLATE



I shall now give a few instances from personal experience to show that mutual adjustment would seem to be a more potent factor in evolution than conflict. A torrential stream, for instance, is a very exacting environment for plants and animals to live in, but it supports a varied fauna and flora adapted for life in its various habitats and niches. Of these, the organisms living on bare rocks in swift currents bear the greatest impact of the environment. By undergoing remarkable structural and physiological modifications, step by step, they have invaded swifter and swifter currents. In this striking adjustment of the organisms to the torrential environment one finds instances of parallel evolution, such as the suctorial disc of the fishes of the genus *Garra* and of the tadpoles of the frog genus *Staurois* (see Plate fig. 2) ; the horizontally striated disc of the Sisorid fish genera *Pseudecheneis*, *Parapseudecheneis* and *Parpseudecheneis* and the limpet-like form assumed not only by fishes (See Plate fig. 3) but also by insect larvae of diverse orders, such as Coleoptera, Hemiptera, Diptera, Ephemeroptera and Odonata.

It will be seen that, though the end-results seem to subserve the same purpose, that is, to withstand the tearing away force of the torrential currents, and to secure an anchorage on bare rocks, the means employed to achieve these results are different. In other words, evolution is both divergent and convergent. This is so because, as Borradaile said many years ago (1923), 'with whatever initiative organisms may have been endowed at their origin, *they have not escaped continuous moulding by their surroundings* during their evolution.'

There is undoubtedly a process of selection in evolution, but not in the Darwinian sense which envisages struggle and conflict. To my way of thinking, Natural Selection is not a *force*, but a *method ;* and I agree with Keer (1926) 'that the role of natural selection is to keep the organism in direct adaptation to its environmental relations, so that as these latter change the organism changes with them'. For instance, if we consider the origin and evolution of the torrential fauna, we can interpret the role of Natural Selection in this way. Suppose an animal capable of stemming a current flowing at the rate of x feet per second in a dry season takes to a habitat where the current flows at the rate of $x+y$ feet per second in the rainy season. If $x+y$ is only slightly greater than x, then the less vigorous will be weeded out, but some of the more vigorous animals may be able to stem it by slight adjustment of their parts which would probably result in the increased efficiency of their organs of attachment. But if, on the other hand, $x+y$ is considerably greater than x, the result would be a wholesale reduction of the animals which would leave no possibility of any selection being made. Thus, Natural Selection is just a method and not a force.

Principles of Organic Evolution

In my Anniversary Address to the National Institute of Sciences of India on "Adaptation and Evolution", I put forward the following five principles of organic evolution :

1. New characters, as a rule, arise as modifications of pre-existing structures.

2. The evolution of characters is governed by innate tendencies of heredity, as well as by external environmental influences.

3. New variations or characters, by whatever means they may arise, are tested for their adaptiveness to the external conditions of the existence of the organism concerned.

4. Evolutionary changes are thus directed towards achieving certain definite objectives.

5. Fluctuations in environmental conditions, whether of the gene-complex or of the animal as a whole, are the main sources of variations and thereby of the production of new characters.

These conclusions are in complete accord with Sir J. C. Bose's opinion that '*it is a misunderstanding of the Laws of Nature to regard conflict as the only factor in Evolution ; far more potent than competition is mutual aid and cooperation in the scheme of life.*' Let us now consider briefly the application of this biological principle to human affairs.

Conflict *versus* Adjustment in Human Affairs

Two great wars within twenty-five years have clearly demonstrated that the future progress and evolution of the human race cannot be through "conflict", for these wars have created more problems than it was thought they would solve. The great advance in the physical sciences, particularly in nuclear physics, the product of the Second World War, now threatens the extermination of the human race besides all else that has life. Realising the dangers of nuclear energy, if misused, all nations, big or small, are now anxious for a real peace, though some governments may still be adverse to it. The Prime Minister of India, Shri Jawaharlal Nehru, has felt that the best guarantee for world peace and for friendship between countries is to adhere to the following five principles now universally known as *Panch Shila* :

1. Recognition of each other's sovereignty, independence and integrity ;
2. Non-aggression ;
3. Equality and mutual respect ;
4. Non-interference in the domestic affairs of any country ; and
5. Promotion of conditions for peaceful co-existence.

These principles not only envisage avoidance of conflict and competition, but also a vast expansion of mutual aid and cooperation. As several nations have now subscribed to these principles, and several others are feeling their useful effects in easing world tension, it may be stated that 'co-existence', which signifies negation of conflict and promotion of cooperation, is now being increasingly recognised as the most acceptable solution of world problems. Shri V. K. Krishna Menon, in referring to the Goa issue, is reported to have stated at Bombay on September 8, 1955, in his address to the Youth Rally on "The Role of Students in International Affairs", that 'Compromise becomes necessary, for their is no life without compromise. Compromise is not surrender. It is finding new values out of contradicting views. The only alternative to this is destruction. Therefore, we are for discussions and negotiations to find ways and means to solve issues.' He added : 'We have got to have co-existence. By trial and error, by force of circumstances, it is now being recognised that war has become sterile.' He also pointed out to the Youth Rally that 'Politics is necessary to build your capacity to take part in national life. It is very largely this capacity which by force of example can show what we stand for.'

These views arise from life-long political and human experience. But what is implied in *Panch Shila*, and stated in the quotations from Shri Krishna Menon's address, are implicit in what Sir J. C. Bose said in his memorable discourse on "The Unity of Life" : that is, that mutual aid and cooperation are far more potent factors in the scheme of life than conflict. And the evidence which has accumulated in the biological sciences since then, of which I have tried to indicate only a very small part, lends full support to the universal application of *Panch Shila* for securing peace, happiness and prosperity for all mankind—and for ensuring its further evolution along creative and rewarding lines.

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Explanation of Plate

FIG. 1. Three species of the Mayfly nymph *Baetis* showing correlation between swiftness of current and degree of reduction in median caudal seta. *a. B. tricaudatus* ×12 ; *b. B. intermedius* ×10 ; *c. B. bicaudatus* ×12.

FIG. 2. Ventral view of head and body of *Garra phillipsi* Deraniyagala ×2-4/5 and *Staurois afghana* (Günther) ×3-3/5 illustrating the parallel evolution of the suctorial disc.

G. 3. Ventral view of head and anterior half of body of the fishes of the family Homalopteridae, Gastromyzonidae and Sisoridae to show the parallel evolution of the body form for adjustment to the environment.

1. *Pseudogastromyzon fasciatus* (Sauvage) ×20/21.
2. *Sinogastromyzon sahoensis* Fang ×1-2/3.
3. *Coraglanis kishinouyei* (Kimura)
4. *Myersglanis blythi* (Day) ×5.

DIRECTOR'S REPORT

(Presented to the 38th Anniversary meeting of the Bose Institute on November 30, 1955)

To-day we are celebrating the 38th Anniversary of the foundation of the Bose Institute, on November 30, 1917, by Acharya Jagadish Chandra Bose, which happens also to be the 97th Anniversary of his birthday. The Governing Body of the Bose Institute has since 1938 instituted an annual memorial lecture to be delivered on each anniversary day by a person of eminence, who has made a substantial contribution to the advancement of knowledge specially in subjects in which the Founder of this Institute was interested.

Dr. Sunder Lal Hora, Director, Zoological Survey of India, has kindly accepted the invitation of the Council of the Bose Institute to deliver the 17th Acharya Jagadish Chandra Bose Memorial Lecture and he was chosen as his subject "Conflict *versus* Cooperation as Factors in Evolution". If I may anticipate a portion of the address which we shall hear presently where Dr. Hora says that his selection of the theme "Conflict versus cooperation" owes something to the presidential address delivered by Acharya Jagadish Chandra in 1927 before the Lahore Session of the Indian Science Congress. Dr. Hora quoted the following line from the address: "It is a misunderstanding of the law of Nature to regard conflict as the only factor in evolution, far more potent than competition is mutual aid and cooperation."

Acharya Jagadish Chandra Bose at one period of his life (about 1907) was very friendly with Prince Kropotkin, the Russian intellectual and anarchist, who was living in London as an exile. Prince Kropotkin had presented Jagadish Chandra with some of his books like "Memoirs of a Revolutionist", "Mutual Aid". It was the latter book which I believe had greatly influenced Jagadish Chandra's views on the influence of mutual aid and cooperation in the evolution of life, a view which was also shared by Geddes and Thompson. We are indebted to Dr. Hora for drawing our attention to this aspect of J. C. Bose's views on the nature of evolutionary forces.

Before proceeding with the other part of my address which is a report on last year's working of the Bose Institute, I would like to draw your attention to the approaching centenary of the birth of the Founder which will be due on 30th November, 1958. The many-sided contributions of Jagadish Chandra to national greatness is everywhere recognised by his fellow countrymen. We hope the forthcoming centenary will be made the occasion for a nation-wide celebration and for a more

intensive study and appreciation of his many-sided activities. A proposal has recently emanated from the Ministry of Education for the preparation of a documentary film of Jagadish Chandra's life and activities. We have prepared such a narrative, which we hope will provide sufficient material for the proposed documentary film. We have also suggested that if it is decided to proceed with the making of such a documentary film then it may be undertaken in collaboration with the Bose Institute. Many of Jagadish Chandra's experiments on short electric waves, and on mechanical movement of plants, are of very striking nature and capable of being followed even by non-scientific observers when depicted in a film.

As on previous occasions, I propose to give a short account of our recent progress and plans for our future activities. About two years ago we had submitted to the Central Government an estimate of our anticipated expenditure both recurring and non-recurring for the First Five Year Plan. Last May we were again invited to submit revised proposals for incorporation in the Second Five Year Plan, commencing from 1956–57. In the revised estimates we have asked for a non-recurring grant of about Rs. 20 lakhs out of which about Rs. 4/- lakhs is for a new building programme. Without this additional building it will not be possible to provide accommodation for additional staff and apparatus required for extending our research programme.

At the present Calcutta location, 93/1 Upper Circular Road, we are reaching a saturation point as regards availability of building site. We have to look for additional land for extension of our laboratory accommodation. The only site adjoining the Institute ground is a vacant plot to the west, which is owned by the Corporation of Calcutta. We hope it will be possible for the Corporation to give on lease the whole or that portion of the land lying vacant to our west, which is not under any commitment.

Plant Breeding.—We have reported from time to time our progress in plant breeding investigations, for which we use two experiment stations at Falta and at Shamnagar. The last named one recently acquired is in course of development. Some staff and office quarters tool shed and store rooms have been constructed. We have started the construction of a laboratory building for which we have received a grant of Rs. 40,000/- from the Government of West Bengal. We propose to locate at Shamnagar that part of our plant science work which deals with investigations on the effect of radiations in producing physiological and genetical changes in plants. We had so far been interested in propagating such plant mutants which have only improved economic ties compared to the parent plants. These investigations, confined hiefly to jute and oil seed plants, were carried out under grant-in-aid schemes. It is now necessary to take up the study of the radiation

effects induced from a wider genetical point of view. We started with X-ray irradiation of seeds. Since last year we have obtained better results by soaking the seeds in radioactive salts of phosphorus and sulphur. Both these elements which emit β-rays are preferentially absorbed in the cell nuclei which is the seat of the hereditary properties of the plants. Some newer effects not previously observed with X-rays have been obtained.

The Head of the Department of Botany of the Institute, Dr. K. T. Jacob has recently returned from a ten-week tour, during which he visited the important stations in Sweden and the U.S.A. where the effects of radiation on plant breeding both from the theoretical and the practical points of view are being studied on a large scale. In addition Dr. Jacob underwent an intensive course of training on the handling of isotopes at the Atomic Energy Station at Oakridge in the U.S.A. Dr. Jacob has been deeply impressed with the recently developed method of using the gamma radiation from cobalt 60 on plants growing in fields. Plants of different species are sown in adjoining circular segments of concentric circles with the source of radiation at the centre. Radioactive cobalt of strength from about 100–200 curies is used as source of gamma-ray radiation. By such a procedure it is possible to observe simultaneously on different plant species the effect of radiation of different total intensity. Isotope Co^{60} can be produced comparatively cheaply by Atomic Reactors. The difficulty of the work lies in providing adequate and fool-proof protection for workers who actively carry on the investigations as well as for those who work in adjoining fields. For this kind of investigations large fields of several acres in size adequately fenced and provided with elaborate protection devices are required. Neither at Falta nor at Shamnagar will it be possible to provide the necessary large plots of land. Possibly with the cooperation of the Agricultural Department, West Bengal such investigations can be undertaken. The line of work is promising, but due to hazard of radiation damage, it can only be undertaken under expert supervision, with elaborate protection devices and methods of checking up the radiation absorbed by the working personnel. In the radiochemical and nuclear physics laboratories of the Bose Institute the apparatus and methods for handling radio isotopes and for checking up exposure of personnel to radiation are continuously studied. Therefore, such undertaking will not be too difficult for us.

Besides the well established ability of gamma rays from Co^{60} to produce new mutants of wheat which are rust resistant, it has recently been found at Brookhaven, New York that by exposing stored potatoes to γ-radiation from Co^{60} sprouting can be greatly reduced or inhibited for doses varying from 5,000 to 20,000 'r' units. This
tion method may eventually replace the more costly one of cold

of potatoes, as even after 18 months there was no undesirable taste evolved in the stored potatoes.

As I have mentioned earlier we have obtained with radio-isotopes some newer results not previously obtained from irradiation with X-rays on jute seeds, of both *Olitorius* and *Capsularis* species. Some of the mutants of R26 produced by treatment with radioactive phosphorus show such striking differences in colour, red and green, that their progenies provide convenient specimens for Mendelian studies. Promising results have been obtained by irradiation of oil seeds of the species of *Seasamum* and *Brassica.*

Microbiology.—In the Microbiology Department irradiation with ultraviolet light of different useful fungi and other soil micro-organisms is being undertaken with a view to studying the mutations produced and also to select and propagate the economical mutants.

The survey of soil micro-organisms obtained from different localities with a view to isolating and culturing those with promising antibacterial and antifungal properties is being continued. For the purification of the essential products, a 24-tube counter-current apparatus has been constructed in the workshop and is being used. A 100-tube counter-current apparatus imported from Germany will soon be put into operation. The role of soil micro-organisms in potentiating some types of herbicides like Craig's herbicide and that of other micro-organisms present in the intestine of tadpoles in synthesizing Vitamin B_{12} has been studied in cooperation with the Departments of Botany and Zoology.

At the last annual meeting the role of vitamin B_{12} in effecting metamorphosis of tadpoles which were kept in the larval state for more than one year by penicillin treatment was reported. Further investigation has shown that some of the intestinal micro-organisms of normal tadpoles secrete vitamin B_{12}; in the penicillin-treated tadpoles on the other hand the intestinal micro-organisms have been found to be deficient in B_{12} production. Thyroxine is also effective in producing metamorphosis of tadpoles kept in the larval condition by penicillin treatment. These two substances are of entirely different chemical composition and the mechanism of their similar effects on retarded tadpoles requires to be elucidated.

Chemistry.—During the past year, a radiochemistry laboratory has been started with a couple of new rooms, one of which is used for radiochemical processing and the other for measurement of radioactivity present in different metabolic products of treated plants. This laboratory together with those which are being developed for researches in physical chemistry, for the study of plant enzymes, the chemical aspect of plant physiology, of biological genetics, will enable the Institute to investigate all aspects of plant science from the chemical point of

The investigations on enzymes will be carried out in a low temperature laboratory which is nearing completion.

Movement of plant organs.—Since the time of J. C. Bose the nature of the motility in plants with active pulvini, like *Mimosa* and *Desmodium*, has been actively studied in the Bose Institute. A comparative study of the staining characteristic of motile and non-motile plant cells has shown that the former contain a large concentration of a stainable substance—tannin-like bodies in the vacuoles of the contractile cells. It has been found that in the active cells of *Mimosa* pulvini, the vacuoles occupy almost the whole of the cell volume and during contraction a large amount of vacuolar fluid is ejected from the active cells, which is again re-absorbed when the pulvinus recovers its original shape. The recovery takes place in 15 minutes and it has not been possible to detect any change in respiration following contractions and recovery. There is a great deal of similarity between the contractile mechanism of *Mimosa* pulvinus and of *Amoeba*, both of which possess large contractile vacuoles.

Another type of motility is shown by the pulvinus of the autonomous pulsating plant like *Desmodium*. Here the vacuole is small compared to the cytoplasm volume ; it has not been possible so far to detect any ejection of cell fluid from the pulsating pulvinus of *Desmodium*. The change in the rate of respiration during each pulsation of the latter can be easily detected with a micro-respirometer. The spiral movement of the *Desmodium* pulvinus has a great deal of similarity with the whip-like movement of many bacterial flagella. The latter has been found to contain a fibrous protein body similar to myosin, which constitutes the frame-work of contractile skeletal muscles.

If the observations made on the differences in the contractile mechanism in *Mimosa* and *Desmodium* pulvini are confirmed by further investigations then it would appear that both in the plant and in animal organisms two different contractile mechanisms have been evolved ; in the one group there is a mechanism by which fluids are ejected from contractile cells, whose typical examples are pulvinar cells of *Mimosa*, amoeba, and secreting cells of the kidney. In the other group the contractile mechanism is made up of fibrous protein bodies, as in bacterial flagella, skeletal muscle and probably also in *Desmodium* pulvinus. This can be taken as another instance of Nature evolving analogous organism independently in plants and in animals for performing similar functions.

Palaeobotany.—The age of the Saline Series in the Salt Range, Punjab has been subject to prolonged controversy amongst geologists. The generally accepted view was that they were of Cambrian age. The alternative view of the Series being of Eocene (Tertiary) age was

supported by the late Prof. Birbal Sahni, on the evidence of the presence in them of vascular plant remains in microfossils discovered by him.

The controversy then centred round the question whether microfossils of vascular plants can be found in rocks of undoubted Cambrian age. To test this possibility an investigation was started in the Botany Department of the Calcutta University, which was later in 1948 taken over to the Bose Institute. The presence of such microfossils was established in definite Cambrian Beds of the Salt Range in the Punjab, Kashmir and Spiti. This result has since then been independently corroborated by the Geological Survey of India.

Examination, in the Bose Institute, of Cambrian rocks from the USA has given identical results. Independent evidence of the occurrence of similar vascular plant remains in Cambrian rocks has been reported from USSR, Canada and Esthonia.

It is now fairly well established from microfossil evidence that the origin of vascular plant can be traced back to the Cambrian times and not to the Silurian—Devonian period as is generally believed. These findings have important theoretical significance in studies on the phylogeny of plants and has practical application in the age determination of the early Palaeozoic sedimentary strata.

Physics.—The apparatus for a microwave laboratory, where J. C. Bose's pioneering investigations on very short electric waves can be continued, are expected soon and the laboratory will be in operation within one year.

Cosmic ray investigations have been continued successfully for several years in the Institute. The apparatus employed are large and small pressure-ionisation chambers, counter-telescope, counter controlled Wilson chamber etc.

A small Wilson chamber 15 cm. in diameter and a medium sized electromagnet, in whose field of strength of 8–10 kilo gauss the chamber can be placed, have been constructed for cosmic ray work a year ago. Some difficulty was encountered in the building up of a motor generator unit to supply the low resistance electromagnet coils with electrical power up to 25 kv. Both the electric motor and the D.C. generator have been obtained. It is expected to start work soon on mapping the low energy spectra of positive and negative muons.

An increasing proportion of our cosmic ray investigations is being carried out at Mayapuri, Darjeeling. Our unit will participate in intensity of cosmic ray measurements connected with the International Geophysical Year during 1958. The observations will be made with the large pressure-ionisation chamber, a square meson telescope and a neutron monitor.